Cairo University
Faculty of Engineering
Computer Engineering
CMPN450 - Pattern Recognition

Lab Exam (1)

Note that: You will need to write code for problems indicated with 💻.

💻 Problem 1 (30 minutes):

Read the one-dimensional data in the file **data.csv**, it's required to find the number of elements in the even indices that are actually even numbers, and the number of elements in the odd indices that are actually odd numbers, and print their sum in both cases. The indices are zero-based.

Example: For a given array A = [2, 5, 7, 6, 8, 9, 0, 4], you should output the following:

- The number of elements in the even indices that are actually even are: **3** "since **A[0] = 2**, A[2] = 7, **A[4] = 8**, **A[6] = 0**"
- The number of elements in the odd indices that are actually odd are: **2**.
- The sum of elements in the even indices that are actually even: **10**.
- The sum of elements in the odd indices that are actually odd: **14**.

NOTE: You should NOT use any loops or list comprehension for this task. Your code should be vectorized.

💻 Problem 2 (20 minutes):

Consider the four-dimensional two-class classification problem below. It's required to classify the point $x = [2 \;\; 3 \;\; -1 \;\; 0]^T$ to one of two classes C_1 and C_2. The a-priori probabilities of the two classes are $P(C_1) = 3/4$ and $P(C_2) = 1/4$. The mean of the two classes are $\mu_1 = [0 \;\; 2 \;\; 1 \;\; 4]^T$ and $\mu_2 = [-1 \;\; 4 \;\; -2 \;\; 1]^T$. The covariance matrices of the two classes are:

$$\Sigma_1 = \begin{bmatrix} 3 & 0 & 1 & 0 \\ 0 & 4 & 2 & 1 \\ 1 & 2 & 5 & 3 \\ 0 & 1 & 3 & 2 \end{bmatrix}, \quad \Sigma_2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 3 & 0 & 0 \\ 0 & 0 & 5 & 2 \\ 0 & 0 & 2 & 5 \end{bmatrix}$$

$$P(x|C_i) = \frac{1}{(2\pi)^{\frac{N}{2}} |\Sigma_i|^{\frac{1}{2}}} \exp\left(-\frac{1}{2}(x-\mu_i)^T \Sigma_i^{-1} (x-\mu_i)\right)$$

Problem 3 (10 minutes):

Consider the two-dimensional three-class classification problem below. Plot (roughly estimate not to scale) the 2D-projection of the Gaussian distributions of the three classes. It's sufficient to draw the contour lines in the supplied grid in the answer sheet given that $\mu_1 = [0 \quad 0]^T$, $\mu_2 = [0 \quad 5]^T$, and $\mu_3 = [5 \quad 2]^T$ and that the covariance matrices of the three classes are:

$$\Sigma_1 = \begin{bmatrix} 2 & 2 \\ 2 & 8 \end{bmatrix}, \quad \Sigma_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, \quad \Sigma_3 = \begin{bmatrix} 5 & -1 \\ -1 & 1 \end{bmatrix}$$

Answer sheet

Problem (1):

- The number of elements in the even indices that are actually even are: ....
- The number of elements in the odd indices that are actually odd are: ....
- The sum of elements in the even indices that are actually even: ....
- The sum of elements in the odd indices that are actually odd: ....

Problem (2):

- Point x is classified as class ....
  Because ....
  ....
  (provide numeric values to prove your answer).

Problem (3):