**MACHINE LEARNING FROM DATA**

**Report: Lab Session 1 – MAP and Gaussian data**

**Classification criteria based on maximizing posterior probability**

**Names:**

Instructions

Handling your work:

* Answer the questions in this document with the name **Mlearn\_Lab1\_report\_team\_surnames.doc**

Questions

Q1: Derive the expression for the eigenvalues of the matrix  as a function of the parameters  and . (edit equations or solve by hand and scan and insert an image with the solution)

Q2. Create a table including error probabilities obtained by the linear classifier (LC) and error probabilities obtained by the quadratic classifier (QC), for each SNR value on the test set. Discuss the results.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 3 dB | 0 dB | -3 dB | -10 dB |
| LC |  |  |  |  |
| QC |  |  |  |  |

Q3. Include in the report the confusion matrices obtained for SNR=-10db and SNR=-3dB and the two classifiers on the test set. Discuss the results.

|  |  |  |
| --- | --- | --- |
|  | -3 dB | -10 dB |
| LC |  |  |
| QC |  |  |

Q4. Include in the report the ROC curves obtained for SNR=-10db and SNR=-3dB and the two classifiers on the test set. Discuss the results.

|  |  |  |
| --- | --- | --- |
|  | -3 dB | -10 dB |
| LC |  |  |
| QC |  |  |

Q5. Compute the Mahalanobis distance between the two classes on the test set for SNR= 3, 0, -3,-10 dB. Compare the results. Explain why the result differs depending on the order of the parameters.

**QPSK and covariances of all classes identical but arbitrary (case 2)**

Q6. Include the scatter plot, decision boundary, confusion matrices and error probabilities obtained using the linear classifier (LC) and the quadratic classifier (QC) for **= 0. Compare the metrics for the two classifiers and discuss the results.

Q7. Repeat the previous analysis (Q6) for **= 0,5. Compare the metrics for the two classifiers and discuss the results.

Q8. Compare and discuss the results obtained in Q8 and Q9

**QPSK and different covariance matrices (case 3)**

Q9. Include the error probabilities obtained using the linear classifier (LC) and the quadratic classifier (QC) for SNR = +5 dB and +10 dB. Compare the metrics for the two classifiers and discuss the results.

|  |  |  |
| --- | --- | --- |
|  | 5 dB | 10 dB |
| LC |  |  |
| QC |  |  |

Q10. Complete the table with the theoretical eigenvalues using the formula obtained when answering Q1, and the eigenvalues computed using the **sample** data covariance matrices. Add the code to compute the eigenvalues of each covariance matrix; use scipy.linalg.eigvals (for just one SNR value)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SNR=?? | Class 1 | Class 2 | Class 3 | Class 4 |
| Theoretical eigenvalues |  |  |  |  |
| Eigenvalues from sample covariance matrices |  |  |  |  |

Q11. Include scatter plots for the linear and quadratic classifiers using SNR= +5 dB and SNR= +10 dB. Relate the shape of the clusters with the eigenvalues of the covariance matrices.

Q12. Include error probabilities, scatter plots and decision boundaries. Compare the performance of the classifier and justify the results. Include in your answer the new value of sigma[0].