CS669/DS403 Assignment 1

September 22, 2022

Note.

i. This is an **individual** assignment.

ii. You should not use an ML library. For example, you cannot use `scikit-learn` or similar.

iii. Submit a report with figures and discussions. The report should be named as `PRA1_rollnum.pdf`. Roll number is in lowercase. If you use a different name, your submission will not be considered.

iv. The report should include a Google Colab page with your code and outputs.

v. The assignment is due on **10 October 2022.**

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1. You are going to perform speech activity detection (SAD.) Given a sequence of signal frames, classify each frame as speech or non-speech. Two types of 1-D features are provided: short-time energy, and Mel-filterbank energy. Which of these features are better at correctly detecting speech? Plot ROC curves to justify your choice.

    - You can use a simple unimodal Gaussian to estimate the distribution of the features. Use sample mean and sample variance as parameters of the Gaussian.
    - The ground truth files are provided with 1 meaning speech and 0 meaning non-speech.
    - Use Segment 2 for estimating the model and segment 3 for testing (ie ROC curves will be computed on Segment 3.)

- Refer to ROC curves in Duda's textbook (Sec 2.8.3)

Expected outputs
Plot of ROC curves for each feature used.

2. Develop a Bayes classifier with Gaussian class conditional densities to classify two datasets, each having 3 classes. The first dataset is linearly separable, and the second is not. Use random 50% of data for training and 50% for test. Build the following classifiers *C1*-*C4*:

   - *C1*: Covariance for all classes is $\mathbf{I}\sigma^2$. Use the average of the sample variances for all dimensions, for all classes, from the training data as σ^2.
   - *C2*: Full but equal covariance for all classes, Σ. Use the average of the sample covariance matrix from all classes in the train data as Σ.
   - *C3*: Diagonal covariance matrix, distinct for each class. Use variances from the sample covariance matrix for each class.
   - *C4*: Full covariance matrix, distinct for each class. Use the sample covariance matrix for each class.

   Expected outputs

   (a) Summarize the classifier performance as in Table 1. Use separate tables for linear and non-linear data.

   (b) For each classifier, and for each dataset, plot the decision regions with class data in different colours. You will thus have 8 plots. A sample plot is shown in Figure 1.

Classifier	Acc.	Prec.	Recall	F-score
C1	•	•	•	•
C2	•	•	•	•
C3	•	•	•	•
C4	•	•	•	•

Table 1: Format of table for question 2. Acc = average accuracy of all classes, Prec = average precision of all classes, Recall = average recall of all classes, F-score = average F-score of all classes.

Acknowledgement: Q2 is based on a similar one prepared at Speech and Vision Lab, IIT Madras.

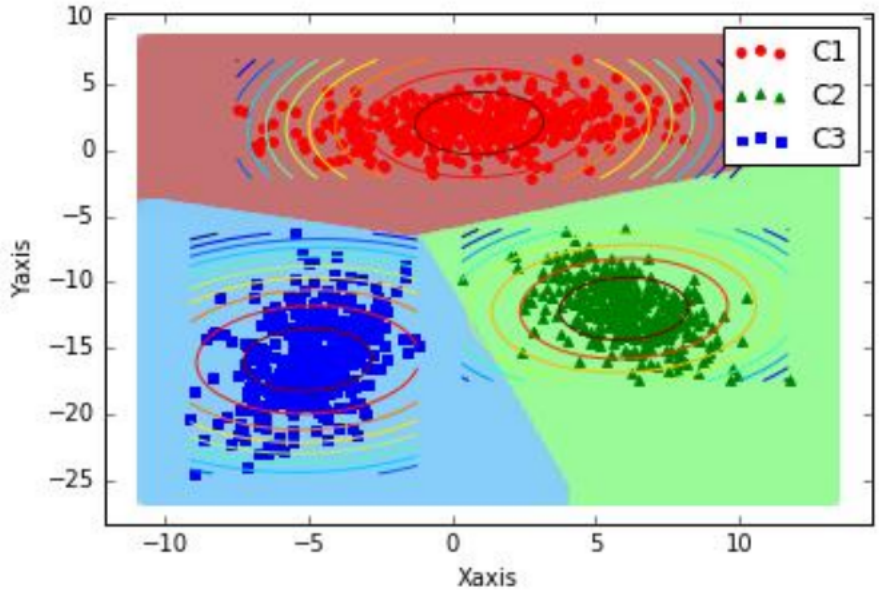

Figure 1: Sample plot for classifier *C2*.