EE527: Machine Learning Laboratory

Assignment 9

Due Date: 03 April 2023

Classification of Normal and Shouted Speech using MFCC features. These features are extracted from speech samples of a number of speakers uttering a few sentences normally or by shouting. The features are divided into train-test splits and are made available in two csv files. You are tasked to learn a discriminative model to classify normal and shouted speech. This example uses discriminative functions. The whole process is described as follows.

Consider the .csv file *"Train_file.csv"* containing *86060* instances of 61-dimensional arrays. The first 60 dimensions of the array contain the feature values for a particular instance and the last dimension contains its label. The label can be either '0' or '1'.

[Q1] Evaluate $\boldsymbol{\mu}_0$, $\boldsymbol{\mu}_1$, $\mathbf{C}_0$, $\mathbf{C}_1$ from instances in *"Train_file.csv".*

$\boldsymbol{\mu}_0$: Mean of all instances having label \`0'

$\boldsymbol{\mu}_1$: Mean of all instances having label \`1'

$\mathbf{C}_0$: Covariance matrix of all instances having label \`0'

$\mathbf{C}_1$: Covariance matrix of all instances having label \`1'.

Construct parameters of the discriminant function with Gaussian assumption on instance distribution in classes.

$$g(x) = ln\left\{\frac{P(X1)}{P(X0)}\right\} - \frac{1}{2}\left(\mu_1{}^T C_1{}^{-1}\mu_1 - \mu_0{}^T C_0{}^{-1}\mu_0\right) - \frac{1}{2} ln\left\{\frac{|C_1|}{|C_0|}\right\}$$
$$+ x^T\left(C_1{}^{-1}\mu_1 - C_0{}^{-1}\mu_0\right) - \frac{1}{2}x^T(C_1{}^{-1} - C_0{}^{-1})x$$

The decision rule for classification of an unseen instance x is given by its label $y(x)$ defined as

$$h(x) = \frac{1}{1 + exp\{-(\omega^T x + \omega_0)\}}$$

$$y(x) = \begin{cases} 1, h(x) \geq 0.5 \\ 0, h(x) < 0.5 \end{cases}$$

[Q2] Perform Logistic Regression on the training dataset to predict the logit value $h(x)$ for input data x as follows.

$$y(x) = \begin{cases} 1, g(x) \geq 0 \\ 0, g(x) < 0 \end{cases}$$

Read *"Test_file.csv"* consisting of *21516* instances of 61 dimensional arrays. For each array, the first 60 dimensions contain the feature values for the test data and the last dimension contains its **actual label**. Predict the label of each data instance from the testing set using the decision rule mentioned above and compare the predicted and actual labels. Report the class-wise (ρ_0 and ρ_1) and overall (ρ) accuracy measures.

$$\rho_0 = \frac{No.of\ Correctly\ Classified\ Instances\ in\ Class\ \text{"0"}}{Total\ Number\ of\ Points\ in\ Class\ \text{"0"}}$$

$$\rho_1 = \frac{No.of\ Correctly\ Classified\ Instances\ in\ Class\ \text{"1"}}{Total\ Number\ of\ Points\ in\ Class\ \text{"1"}}$$

$$\rho = \frac{Total\ No.of\ Correctly\ Classified\ Instances}{Total\ Number\ of\ Test\ Instances}$$