Istanbul Technical University- Spring 2017
BLG527E Machine Learning
Homework 2

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Note: Running *discriminant.py* will save confusion matrix figures in the same directory and write the asked questions in *Q1)* into *output.txt* file.

Q1)

Q1a) Equation 1 is implemented to calculate the discriminant function.

$$g_i(x) = -\frac{1}{2}\Sigma_{j=1}^{d}(\frac{x_j^t - m_{ij}}{s_j})^2 + log\hat{P}(C_i) \tag{1}$$

Q1b) In this question also, quation **??** is implemented to calculate the discriminant function. However, as we assume that all variance are equal formula simplified to equation 2

$$g_i(x) = -\frac{1}{2s^2}\Sigma_{j=1}^{d}(x_j^t - m_{ij})^2 + log\hat{P}(C_i) \tag{2}$$

Class distribution are shown in Figure 1.

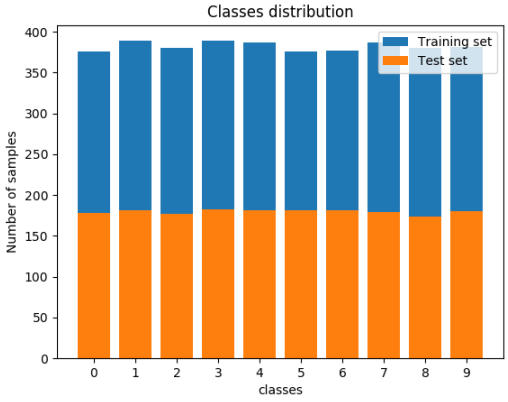

Figure 1: Class distribution in the train and test dataset.

Q1c) Assuming that all variances are equal (Q1b) has the best test error.

Test error of Q1a: 0.106845
Test error of Q1b: 0.106288

Test error per class when assuming diagonal common covariance matrix:

Class 0 error: 0.005618
Class 1 error: 0.258242
Class 2 error: 0.118644
Class 3 error: 0.136612
Class 4 error: 0.060773
Class 5 error: 0.054945
Class 6 error: 0.038674
Class 7 error: 0.033520
Class 8 error: 0.212644
Class 9 error: 0.150000

Test error per class when assuming all variance are equal:

Class 0 error: 0.016854
Class 1 error: 0.252747
Class 2 error: 0.112994
Class 3 error: 0.114754
Class 4 error: 0.088398
Class 5 error: 0.060440
Class 6 error: 0.033149
Class 7 error: 0.050279
Class 8 error: 0.206897
Class 9 error: 0.127778

Figures 2 and 3 show confusion matrix for train set and test when we assume a diagonal common covariance matrix. Also, Figures 4 and 5 show confusion matrix when we assume all variance are equal.

As it can be seen in test set confusion matrix in both assumption, mostly, class 1 is

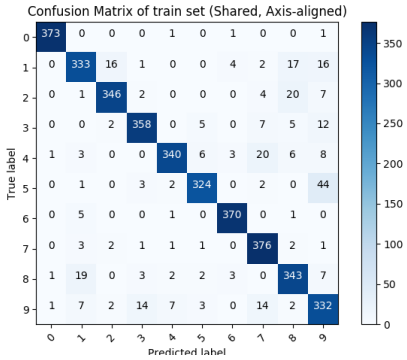

Figure 2: Confusion Matrix of training set Q1a.

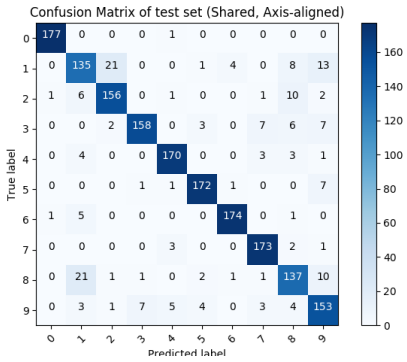

Figure 3: Confusion Matrix of test set Q1a.

miss-predicted as classes 2, 8 or 9, and class 8 is misclassified as 1 or 9.

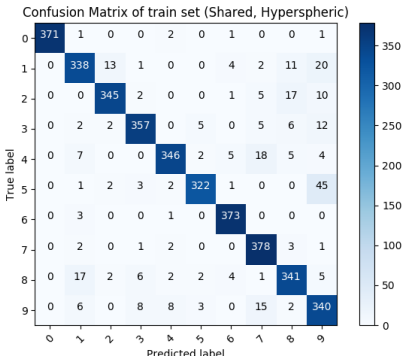

Figure 4: Confusion Matrix of training set Q1b.

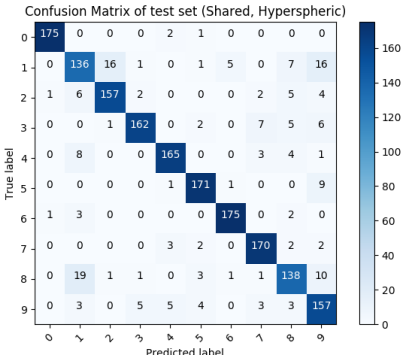

Figure 5: Confusion Matrix of test set Q1b.

Q2): Running *lda.py* will plot and save Figures 6 and 7 in the same directory.

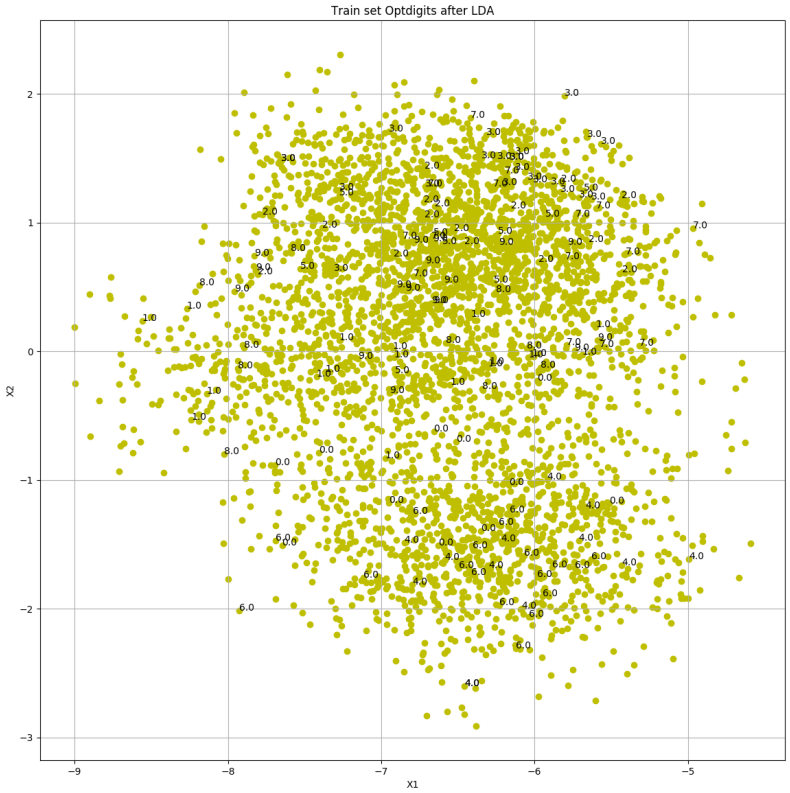

Figure 6: Visualizing train dataset after projecting to 2d using LDA.

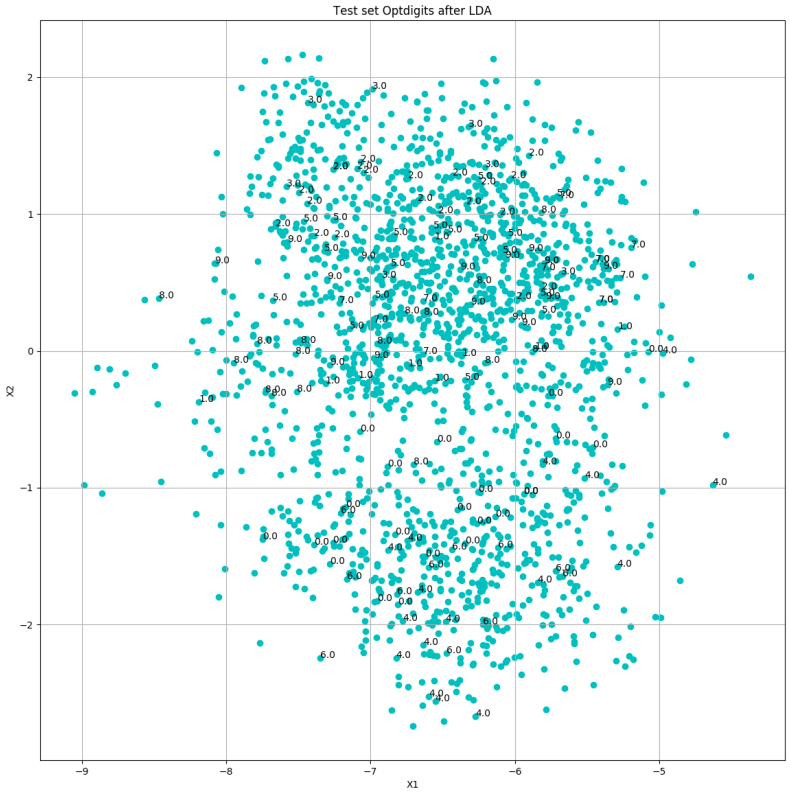

Figure 7: Visualizing test dataset after projecting to 2d using LDA.