# Istanbul Technical University- Fall2017
# BLG527E Machine Learning
# HomeWork2

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Note: Running HW1.ipyn(The code has written in R but in jupyter notebook) Q1) into output.txt file.
please open the jupyter notebook with this command:
jupyter notebook --NotebookApp.iopub_data_rate_limit=10000000000(otherwise, we will have limiting error of array)

Class distribution for our training set in the fig1.

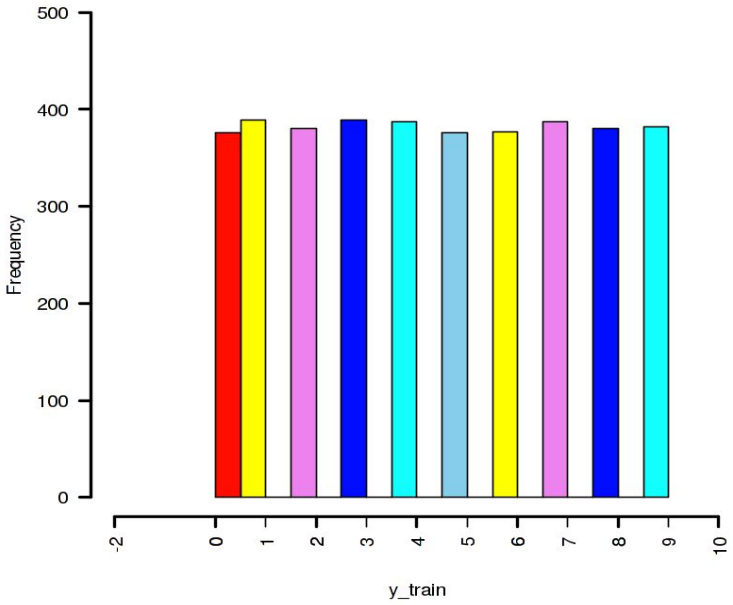



fig1.Class distribution for our training set

Q1a)in this equation, we implement this to calculate the discriminant function to our datapoint.

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

q1b) In equation 2,we calculate he is implemented to calculate the discriminant function. So, the assumption is that all variance are equal formula to the equation

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

After using these discriminant function to training and test set, accuracy and error will be accord below:(Accuracy and other details about the performance of methods is inserted in the code)

Test error of Q1a: 0.106845

Test error of Q1b: 0.106288

Confusion matrix for training and test set, for two type of discriminant function:

| Prediction \ Reference | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 373 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 333 | 1 | 0 | 3 | 1 | 5 | 3 | 19 | 7 |
| 2 | 0 | 16 | 346 | 2 | 0 | 0 | 0 | 2 | 0 | 2 |
| 3 | 0 | 1 | 2 | 358 | 0 | 3 | 0 | 1 | 3 | 14 |
| 4 | 1 | 0 | 0 | 0 | 340 | 2 | 1 | 1 | 2 | 7 |
| 5 | 0 | 0 | 0 | 5 | 6 | 324 | 0 | 1 | 2 | 3 |
| 6 | 1 | 4 | 0 | 0 | 3 | 0 | 370 | 0 | 3 | 0 |
| 7 | 0 | 2 | 4 | 7 | 20 | 2 | 0 | 376 | 0 | 14 |
| 8 | 0 | 17 | 20 | 5 | 6 | 0 | 1 | 2 | 343 | 2 |
| 9 | 1 | 16 | 7 | 12 | 8 | 44 | 0 | 1 | 7 | 332 |

Confusion Matrix of training set of Q1a

| Prediction \ Reference | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 177 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 135 | 6 | 0 | 4 | 0 | 5 | 0 | 21 | 3 |
| 2 | 0 | 21 | 156 | 2 | 0 | 0 | 0 | 0 | 1 | 1 |
| 3 | 0 | 0 | 0 | 158 | 0 | 1 | 0 | 0 | 1 | 7 |
| 4 | 1 | 0 | 1 | 0 | 170 | 1 | 0 | 3 | 0 | 5 |
| 5 | 0 | 1 | 0 | 3 | 0 | 172 | 0 | 0 | 2 | 4 |
| 6 | 0 | 4 | 0 | 0 | 0 | 1 | 174 | 0 | 1 | 0 |
| 7 | 0 | 0 | 1 | 7 | 3 | 0 | 0 | 173 | 1 | 3 |
| 8 | 0 | 8 | 10 | 6 | 3 | 0 | 1 | 2 | 137 | 4 |
| 9 | 0 | 13 | 2 | 7 | 1 | 7 | 0 | 1 | 10 | 153 |

Confusion Matrix of test set Q1a.

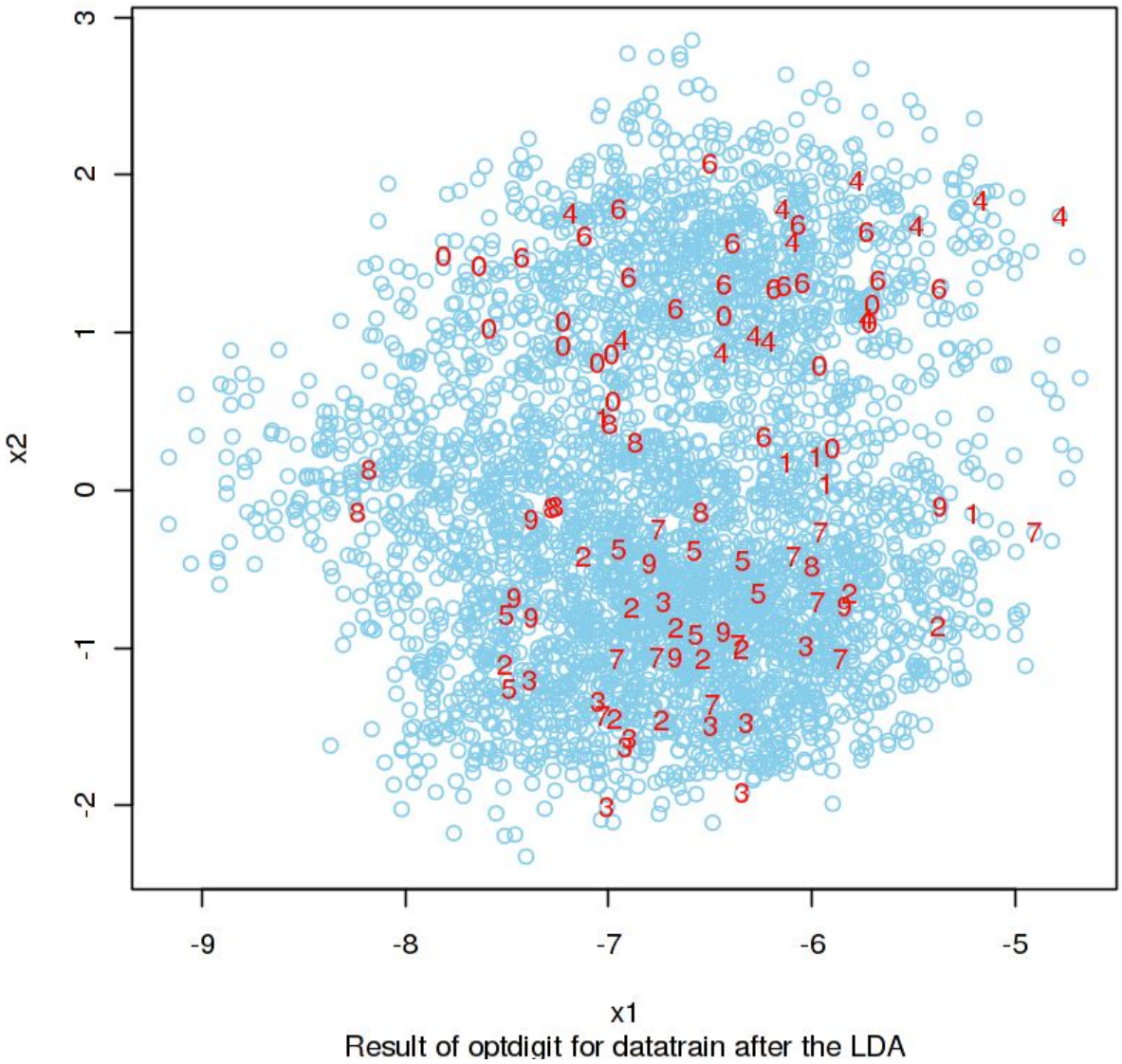
| Prediction \ Reference | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 371 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 338 | 0 | 2 | 7 | 1 | 3 | 2 | 17 | 6 |
| 2 | 0 | 13 | 345 | 2 | 0 | 2 | 0 | 0 | 2 | 0 |
| 3 | 0 | 1 | 2 | 357 | 0 | 3 | 0 | 1 | 6 | 8 |
| 4 | 2 | 0 | 0 | 0 | 346 | 2 | 1 | 2 | 2 | 8 |
| 5 | 0 | 0 | 0 | 5 | 2 | 322 | 0 | 0 | 2 | 3 |
| 6 | 1 | 4 | 1 | 0 | 5 | 1 | 373 | 0 | 4 | 0 |
| 7 | 0 | 2 | 5 | 5 | 18 | 0 | 0 | 378 | 1 | 15 |
| 8 | 0 | 11 | 17 | 6 | 5 | 0 | 0 | 3 | 341 | 2 |
| 9 | 1 | 20 | 10 | 12 | 4 | 45 | 0 | 1 | 5 | 340 |

Confusion Matrix of test set Q1b

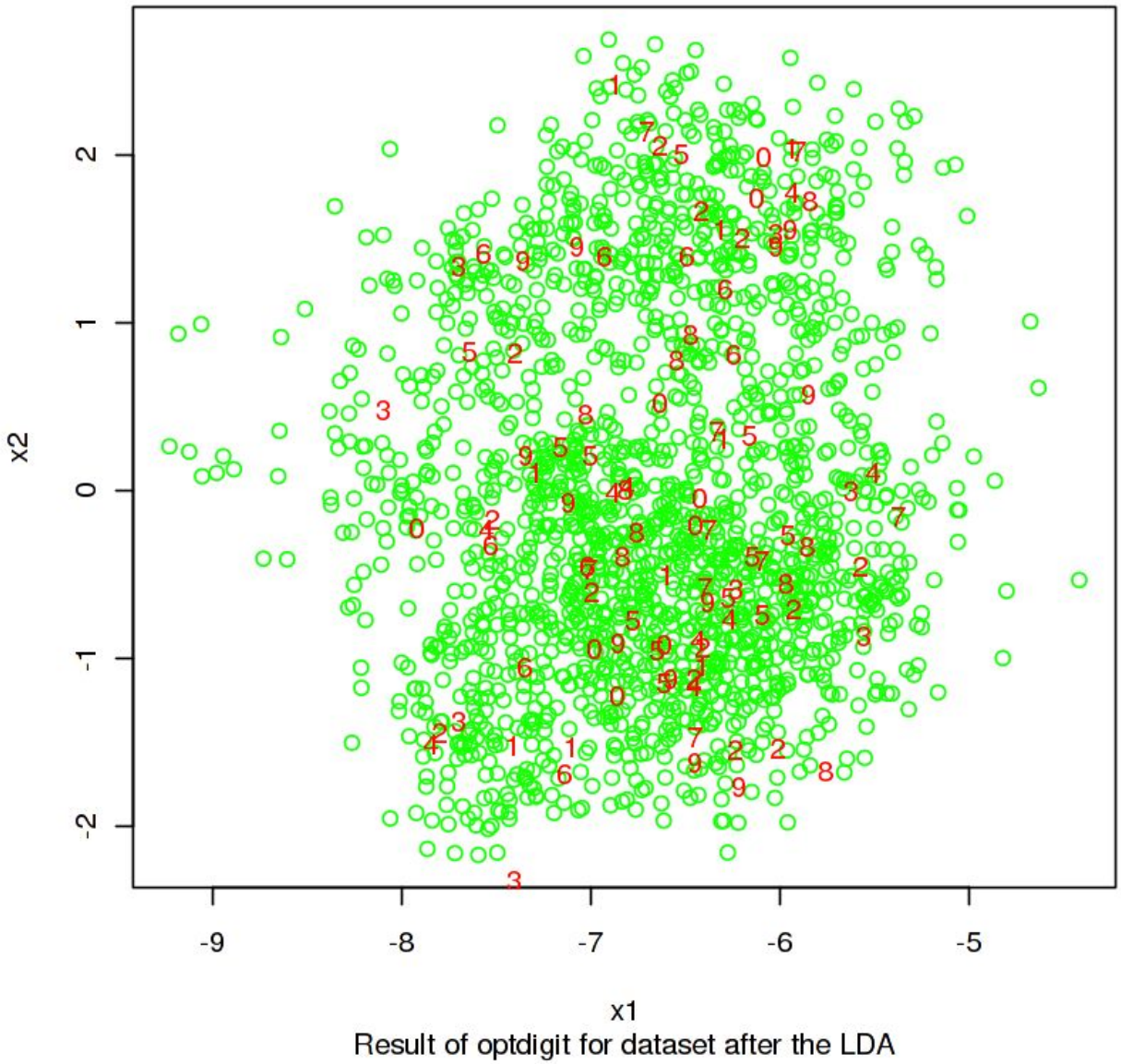
| Prediction \ Reference | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 175 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 136 | 6 | 0 | 8 | 0 | 3 | 0 | 19 | 3 |
| 2 | 0 | 16 | 157 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 1 | 2 | 162 | 0 | 0 | 0 | 0 | 1 | 5 |
| 4 | 2 | 0 | 0 | 0 | 165 | 1 | 0 | 3 | 0 | 5 |
| 5 | 1 | 1 | 0 | 2 | 0 | 171 | 0 | 2 | 3 | 4 |
| 6 | 0 | 5 | 0 | 0 | 0 | 1 | 175 | 0 | 1 | 0 |
| 7 | 0 | 0 | 2 | 7 | 3 | 0 | 0 | 170 | 1 | 3 |
| 8 | 0 | 7 | 5 | 5 | 4 | 0 | 2 | 2 | 138 | 3 |
| 9 | 0 | 16 | 4 | 6 | 1 | 9 | 0 | 2 | 10 | 157 |

Confusion Matrix of test set Q1b

Q2a)after Running the Lda.ipyn you will see the results like the below Figs:




Result of optdigit for datatrain after the LDA




Result of optdigit for dataset after the LDA