Homework 2

The code is submitted at github

https://github.com/mas-dse/w9yan/blob/master/DSE220/homeworks/homework_2/generative.ipynb

Answers:

1. Priors for all lables are:

```
prior probability for label 0 is 0.0987
prior probability for label 1 is 0.1118
prior probability for label 2 is 0.0968
prior probability for label 3 is 0.1013
prior probability for label 4 is 0.1038
prior probability for label 5 is 0.0857
prior probability for label 6 is 0.1013
prior probability for label 7 is 0.1085
prior probability for label 8 is 0.0918
prior probability for label 9 is 0.1002
```

2. Report highest Pji for each label j :

```
highest Pji for label 0 is 0.8519
highest Pji for label 1 is 0.9851
highest Pji for label 2 is 0.7290
highest Pji for label 3 is 0.8082
highest Pji for label 4 is 0.8496
highest Pji for label 5 is 0.7112
highest Pji for label 6 is 0.8492
highest Pji for label 7 is 0.7948
highest Pji for label 8 is 0.8752
highest Pji for label 9 is 0.8673
```

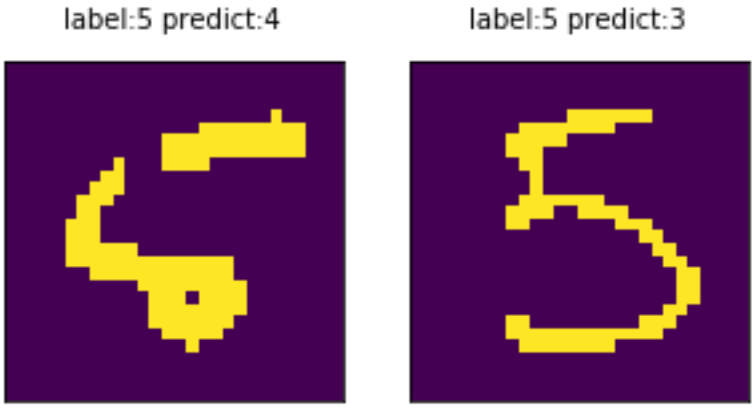
3. With Naïve Bayes classifier, the test accuracy is

```
test accuracy is: 0.8090
```

4. Compute the confusion matrix and report top 3 pairs with most incorrect classifier.

```
[[ 74   0   0   0   0   5   2   0   4   0]
 [  0 120   0   0   0   4   1   0   1   0]
 [  1   7  88   4   0   1   2   3   8   2]
 [  0   2   1  86   1   6   3   2   3   3]
 [  1   1   1   0  83   0   2   0   1  21]
 [  3   1   1  11   2  62   2   3   1   1]
 [  3   0   4   0   3   4  73   0   0   0]
 [  0   6   2   0   3   1   0  77   3   7]
 [  0   2   2   9   4   3   1   2  61   5]
 [  0   1   0   1   4   0   0   0   3  85]]
top 3 pairs(true, predict) with most incorrect classification:
[(4, 9), (5, 3), (8, 3)]
```

5. Visualize mistakes: print 2 misclassified images.



6. Report selected covariance type and according test accuracy.

```
Best covariance type based on validation is: spherical
test accuracy is: 0.0482
```

7. Linear Discriminant Analysis model on the train+validation data and report the accuracy obtained on test data. Report the transformation matrix (w) along with the intercept.

```
Test accuracy = 0.9649
The transformation matrix(w) is:
[[  1.34830116e+00  -1.27341243e-01  -1.35844403e-01  -2.44423845e-04
   -2.24362884e+01   8.56018583e+01   1.38546510e+01  -1.22119406e+02
    1.60043667e+01   7.42980762e+00  -1.47932822e+01   4.82925722e-01
    1.73467322e+00  -1.63578761e-02  -4.69433577e+02  -1.95981999e+00
    1.60421869e+01  -9.77881013e+01  -6.13801471e+01   5.59104687e+02
   -1.26194721e+00  -1.99981038e-01  -2.62323627e-01   1.92964678e-02
    3.19490554e+01   4.09464513e+00  -1.26545911e+01  -9.32147959e+00
   -1.48664190e+01  -1.71510006e+02]]
The intercept is: [ 51.85532978]
```

8. Specificity, Sensitivity, TPR, TNR, FNR, FPR, Precision and Recall for Digit 3

```
specificity: 0.995507637017071
sensitivity: 0.916030534351145
TPR: 0.916030534351145
TNR: 0.995507637017071
FNR: 0.08396946564885499
FPR: 0.004492362982928988
precision: 0.96
recall: 0.916030534351145
```

9. Report the mean squared error and the mean absolute error on the test data

```
MSE: 2155.9646510319635
MAE: 36.31813369867867
```

10. Repeat the experiment from Question 10 for all possible values of ablation

```
MSE after removing feature 0 is : 2152.8066421806125
MSE after removing feature 1 is : 2259.133079371277
MSE after removing feature 2 is : 2783.514481845114
MSE after removing feature 3 is : 2424.772348004414
MSE after removing feature 4 is : 2187.599519380257
MSE after removing feature 5 is : 2167.5176061492357
MSE after removing feature 6 is : 2159.151482507473
MSE after removing feature 7 is : 2153.0631711282294
MSE after removing feature 8 is : 2335.1733846110847
MSE after removing feature 9 is : 2165.8661921931885
```

11. Based on the MSE values obtained from Question 10, the most/least significant feature are below.

```
most significant feature is index 2, because removing feature 2 will cause
 the largest MSE which means more errors were produced without this featur
e.
least significant feature is index 0, because without feature 0 we get com
paratively smallest MSE.
```