CSE 4088 – INTRODUCTION to MACHINE LEARNING

HW4 Report

Zeynep Kumralbaş 150115051

Polynomial Kernels

2) Label of a class is determined as +1, label of other classes is determined as -1 to find one-versus-all classifiers.

Ein for 0-versus-all: 0.105884 Ein for 2-versus-all: 0.100261

Ein for 4-versus-all: 0.089425 Ein for 6-versus-all: 0.076258

Ein for 8-versus-all: 0.074338

0-versus-all classifier has the highest Ein.

Answer is a.

3) Ein for 1-versus-all: 0.014401 Ein for 3-versus-all: 0.090248

Ein for 5-versus-all: 0.076258 Ein for 7-versus-all: 0.088465

Ein for 9-versus-all: 0.088328

1-versus-all classifier has the lowest Ein.

Answer is a.

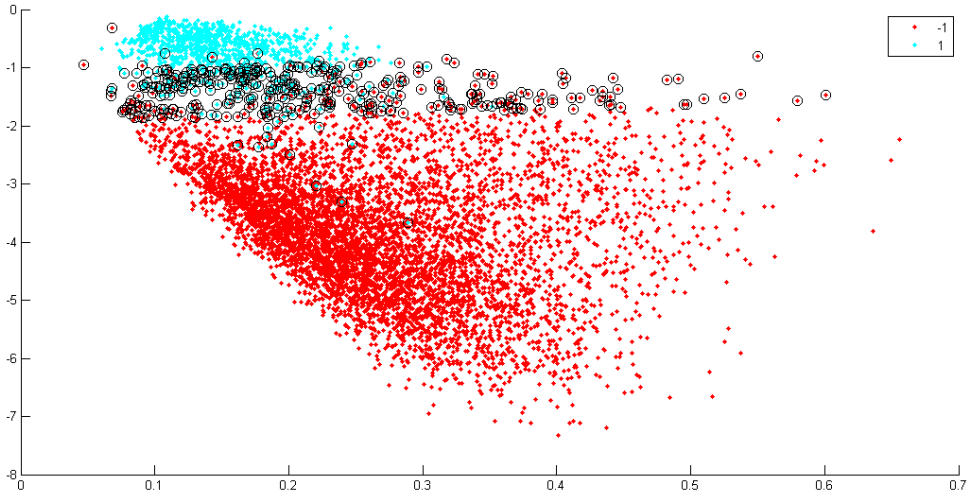

Figure 1: digit 1-vs-all scatter plot

4) Number of support vectors for 0-versus-all: 2180

Number of support vectors for 1-versus-all: 386

The difference is 2180-386=1794. The closest value is 1800.

Answer is c.

5) For 1-vs-5 classifier, label of digit 1s are determined as +1, label of digit 5s are determined as -1, and only features of digit 1 and digit 5 are used. Polynomial kernel and Q=2 are used in fitcsvm function.

- Number of support vectors for C=0.001 is 76.

  Number of support vectors for C=0.01 is 34.

  Number of support vectors for C=0.1 is 24.

  Number of support vectors for C=1 is 24.

  Therefore, statements a and b are false.

- Test data are used to find Eout. Label of digit 1s are determined as +1, label of digit 5s are determined as -1, and only features of digit 1 and digit 5 are used from the test data. The predict function predicts the label of a test data using the model that is found

with the train data. Then, predicted label and the actual label of the test data are compared.

Eout for C=0.001 is 0.016509. Eout for C=0.01 is 0.018868.

Eout for C=0.1 is 0.018868. Eout for C=1 is 0.018868.

Therefore, statement c is false.

- Ein for C=0.001 is 0.004484. Ein for C=0.01 is 0.004484.

  Ein for C=0.1 is 0.004484. Ein for C=1 is 0.003203.

  Maximum C achieves the lowest Ein. Statement d is true.

Answer is d.

6)

- When C = 0.0001, Ein is 0.08969 at Q=2, 0.004484 at Q=5. Ein is higher at Q=2. Statement a is false.
- When C = 0.001, the number of support vectors is 76 at Q=2, 25 at Q=5. Statement b is true.
- When C=0.01, Ein is 0.004484 at Q=2, 0.00384 at Q=5. Statement c is false.
- When C=1, Eout is 0.003203 at Q=2, 0.004484 at Q=5. Statement d is false.

Answer is b.

Cross Validation

7) Training data for 1-versus-5 classifier are partitioned into 10 subsets. 1 subset is used as the test data, other 9 subsets are used as the train data. For each test set, Ecv is calculated. After each subset is used as the test data respectively, average Ecv is used to select C. At the end of 100 runs, the total number of time that each C is selected is found.

C=0.0001 is selected 8 times. C=0.001 is selected 57 times.

C=0.01 is selected 8 times. C=0.1 is selected 2 times.

C=1 is selected 25 times.

C=0.001 is selected most often.

Answer is b.

8) The average value of Ecv over the 100 runs of C=0.001 is 0.005233. It is closest to 0.005.

Answer is c.

RBF Kernel

Fitcsvm function is used with ‘rbf’ parameter for 1 versus 5 classifier. Ein and Eout values are calculated.

9) Ein is 0.003844 for C=0.01. Ein is 0.004484 for C=1.

Ein is 0.003203 for C=100. Ein is 0.002562 for $C=10^4$.

Ein is 0.000641 for $C=10^6$.

The lowest Ein is in the $C=10^6$.

Answer is e.

10) Eout is 0.023585 for C=0.01. Eout is 0.021226 for C=1.

Eout is 0.018868 for C=100. Eout is 0.023585 for $C=10^4$.

Eout is 0.023585 for $C=10^6$.

The lowest Eout is in the C=100.

Answer is c.