CS 156 Problem Set 8

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Problem 1

(D) - Since we're trying to minimize $\frac{1}{2}\mathbf{w}^{\mathrm{T}}\mathbf{w}$, we have a quadratic programming problem. We're also solving for all the entries in $\mathbf{w}$ which gives us d variables, and we need to consider the bias, so we have $d+1$ variables.

Problem 2

(A) - According to our code, the digit 0 has the highest E_{in} with an error of 0.119. The other digits have E_{in} values of 0.1, 0.089, 0.091, and 0.074 for 2, 4, 6, and 8 respectively.

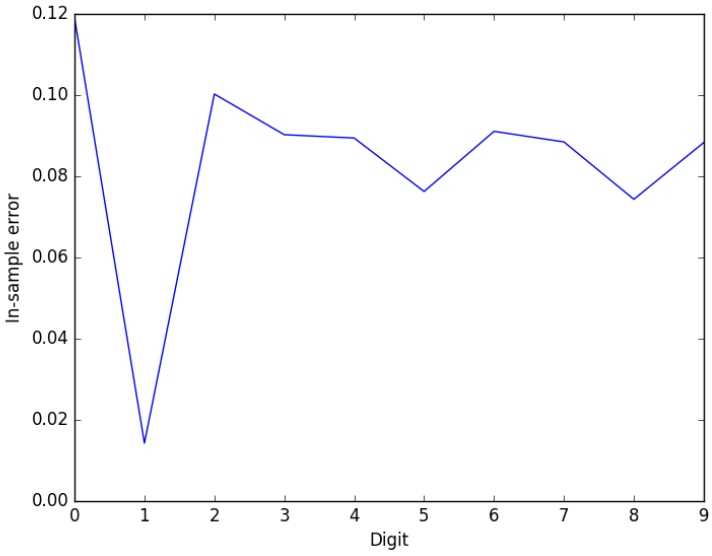

Figure 1: In-sample errors of handwriting data

Problem 3

(A) - The digit 1 has the lowest in-sample error by far with an error of 0.014.

Problem 4

(C) - The total number of support vectors for 0 is 2279 and the total number of support vectors for 1 is 400, so the difference is around 1800.

Problem 5

(D) - The number of support vectors does decrease as C increases from 0.001 to 0.1 (from 76 to 34 to 24), however it remains at 24 when C = 1. E_{out} goes up from 0.016 to 0.018 with increasing C. The only answer choice that is true is that when C = 1 we get the lowest E_{in}, a value of 0.0032.

Problem 6

(B) - In this case, the only answer choice that is correct is that the number of support vectors drops from 76 to 25 when Q increases from 2 to 5. When C = 0.01, E_{in} decreases from 0.0045 to 0.0038. When C = 1 E_{out} increases from 0.0189 to 0.0212. Finally, when C = 0.001, E_{in} is 0.0045 in both cases.

Problem 7

(B) - Out of 1000 trials, 0.001 was selected 457 times, while 0.0001, 0.02, 0.1, and 1 were selected 0, 229, 128, and 186 times respectively.

Problem 8

(C) - The code finds that using C = 0.001, we get an average E_{cv} value of 0.0047.

Problem 9

(E) - The lowest E_{in} occurs when C = 10^6 which makes sense because this is the largest C we tested. The error in this case is $6.4 * 10^{-4}$.

Problem 10

(C) - The lowest E_{out} occurs when C = 100 (actually tied with C = 10, 1000, and 10^5, but the only answer choice is 100) with an error of 0.0189.