COMPSCI 289A Homework 1 **Mitchell Negus**
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*Note: Code was worked on independently

Problem 1

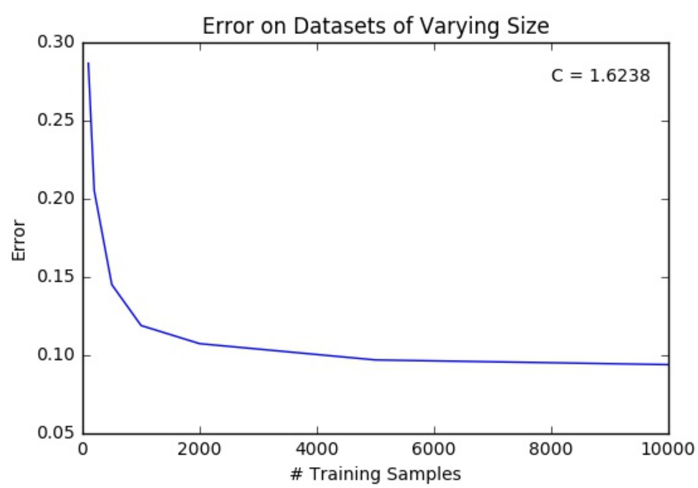
Data was partitioned as specified (10,000 validation images for MNIST, 20% as validation samples for spam, and 5,000 validation images for CIFAR-10). See code, provided in the appendix, for evidence. Partitioning was accomplished by calling the partition function defined in HW01_utils.py module.

Problem 2

The linear SVM was trained on all three datasets. The score (accuracy) of the method was calculated for a range of samples. For each data set–MNIST, spam, and CIFAR-10–the error (error = 1-accuracy) is plotted as a function of N samples used for training.

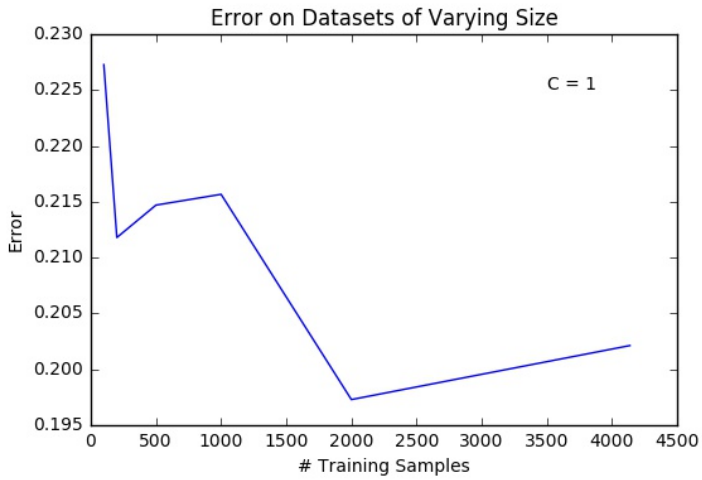
MNIST

Accuracy of MNIST training for 100, 200, 500, 1,000, 2,000, 5,000, and 10,000 training samples.



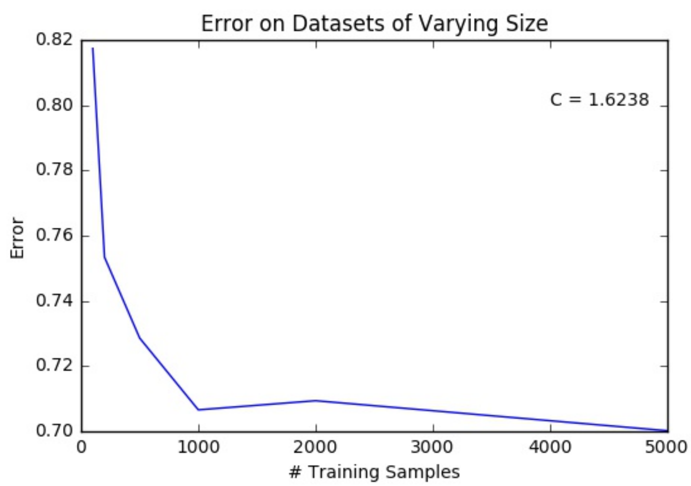
Spam

Accuracy of spam/ham training for 100, 200, 500, 1,000, 2,000, and all (4,132) training samples.



CIFAR-10

Accuracy of CIFAR-10 training for 100, 200, 500, 1,000, 2,000, and 5,000 training samples.



Problem 3

For the MNIST data set, the best value of C was found to be $7.84759970351 \times 10^{-7}$, giving an accuracy of 92.98%. All accuracies for a range of C values (all trained on 10,000 samples) are given below.

10,000 samples

C	**Accuracy**
1.0000E-08	0.8935
4.2813E-08	0.9147
1.8330E-07	0.9255
7.8476E-07	**0.9298**
3.3598E-06	0.9229
1.4384E-05	0.9118
6.1585E-05	0.9071

2.6367E-04	0.906
0.0011288	0.906
0.0048329	0.906
0.0206914	0.906
0.0885867	0.906
0.3792690	0.906
1.6237767	0.906
6.9519280	0.906
29.763514	0.906
127.42750	0.906
545.55948	0.906
2335.7215	0.906
10000.0	0.906

Full results for all sample counts are provided in the appendix.

Problem 4

For the spam/ham data sets, best value of C was found to be 100, giving an accuracy of 80.75%. This value was found using a K-Fold Cross-Validation scheme where $k = 5$. Below are all accuracies for a range of C values when the SVM was trained on 2,000 samples.

2,000 samples

C	**Accuracy**
1.0000E-08	0.710058
3.3598E-08	0.710058
1.1288E-07	0.710058
3.7927E-07	0.710058
1.2743E-06	0.710058
4.2813E-06	0.710058
1.4384E-05	0.710058
4.8329E-05	0.710058
0.00016238	0.717215
0.00054556	0.734429
0.00183298	0.750097
0.00615848	0.768279
0.02069138	0.779304
0.06951928	0.793617
0.23357215	0.8
0.78475997	0.802515
2.63665090	0.804836
8.85866790	0.805029
29.7635144	0.807350
100.0	**0.807544**

Problem 5

My Kaggle Leaderboard name: **mitch**
My Kaggle username: **mnegus**

Kaggle Scores:
MNIST: 0.93360 Spam: 0.84085

Appendix

Below are all accuracies tabulated for tested range of hyperparameter C for N training samples.

Table 1: **MNIST**

$\boldsymbol{N}$\C	1E-08	4E-08	1.8E-07	7.8E-07	3.36E-06	1.44E-05	6.16E-05	0.000264	0.001129	0.004833
100	0.1119	0.2301	0.6438	0.7169	0.7133	0.7133	0.7133	0.7133	0.7133	0.7133
200	0.0963	0.425	0.7747	0.8005	0.7947	0.7947	0.7947	0.7947	0.7947	0.7947
500	0.3171	0.7527	0.865	0.8635	0.8552	0.8548	0.8548	0.8548	0.8548	0.8548
1000	0.5782	0.85	0.8867	0.8909	0.8815	0.881	0.881	0.881	0.881	0.881
2000	0.7981	0.8824	0.9043	0.9086	0.895	0.8926	0.8926	0.8926	0.8926	0.8926
5000	0.8721	0.9038	0.9183	0.9202	0.9135	0.9041	0.903	0.903	0.903	0.903
10000	0.8935	0.9147	0.9255	0.9298	0.9229	0.9118	0.9071	0.906	0.906	0.906

$\boldsymbol{N}$\C	0.020691	0.088587	0.379269	1.623777	6.951928	29.76351	127.4275	545.5595	2335.721	10000
100	0.7133	0.7133	0.7133	0.7133	0.7133	0.7133	0.7133	0.7133	0.7133	0.7133
200	0.7947	0.7947	0.7947	0.7947	0.7947	0.7947	0.7947	0.7947	0.7947	0.7947
500	0.8548	0.8548	0.8548	0.8548	0.8548	0.8548	0.8548	0.8548	0.8548	0.8548
1000	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881
2000	0.8926	0.8926	0.8926	0.8926	0.8926	0.8926	0.8926	0.8926	0.8926	0.8926
5000	0.903	0.903	0.903	0.903	0.903	0.903	0.903	0.903	0.903	0.903
10000	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906

Table 2: **Spam**

$\boldsymbol{N}$\C	1E-08	3E-08	1.1E-07	3.8E-07	1.27E-06	4.28E-06	1.44E-05	4.83E-05	0.000162	0.000546
100	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.709865	0.710445	0.710638
200	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710251	0.711025
500	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.713926
1000	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.711412	0.725725
2000	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.717215	0.734429
4138	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.710058	0.712186	0.725338	0.743327

$\boldsymbol{N}$\C	0.001833	0.006158	0.020691	0.069519	0.233572	0.78476	2.636651	8.858668	29.76351	100
100	0.711605	0.716828	0.728433	0.74236	0.754932	0.770406	0.777756	0.786074	0.775629	0.781044
200	0.716441	0.730174	0.745261	0.758801	0.767892	0.782592	0.789555	0.798066	0.792456	0.786847
500	0.731141	0.745261	0.763636	0.77176	0.783172	0.791876	0.793424	0.793037	0.792456	0.792456
1000	0.741199	0.761896	0.7706	0.784139	0.790135	0.792843	0.797099	0.798646	0.79942	0.798453
2000	0.750097	0.768279	0.779304	0.793617	0.8	0.802515	0.804836	0.805029	0.80735	0.807544
4138	0.763056	0.774855	0.789362	0.794971	0.79942	0.801354	0.802128	0.802901	0.802708	0.802515

Table 3: **CIFAR-10**

N\C	1E-08	4E-08	1.8E-07	7.8E-07	3.36E-06	1.44E-05	6.16E-05	0.000264	0.001129	0.004833
100	0.111	0.1658	0.1834	0.1838	0.1826	0.1826	0.1826	0.1826	0.1826	0.1826
200	0.1026	0.2272	0.2622	0.2466	0.2466	0.2466	0.2466	0.2466	0.2466	0.2466
500	0.2202	0.295	0.3008	0.2842	0.2708	0.2714	0.2714	0.2714	0.2714	0.2714
1000	0.2632	0.3164	0.3306	0.3148	0.2934	0.2934	0.2934	0.2934	0.2934	0.2934
2000	0.3	0.3476	0.345	0.321	0.3016	0.291	0.2906	0.2906	0.2906	0.2906
5000	0.353	0.3736	0.3752	0.3518	0.3216	0.3066	0.2992	0.2998	0.2998	0.2998

N\C	0.020691	0.088587	0.379269	1.623777	6.951928	29.76351	127.4275	545.5595	2335.721	10000
100	0.1826	0.1826	0.1826	0.1826	0.1826	0.1826	0.1826	0.1826	0.1826	0.1826
200	0.2466	0.2466	0.2466	0.2466	0.2466	0.2466	0.2466	0.2466	0.2466	0.2466
500	0.2714	0.2714	0.2714	0.2714	0.2714	0.2714	0.2714	0.2714	0.2714	0.2714
1000	0.2934	0.2934	0.2934	0.2934	0.2934	0.2934	0.2934	0.2934	0.2934	0.2934
2000	0.2906	0.2906	0.2906	0.2906	0.2906	0.2906	0.2906	0.2906	0.2906	0.2906
5000	0.2998	0.2998	0.2998	0.2998	0.2998	0.2998	0.2998	0.2998	0.2998	0.2998

Included on the following pages is the code used for this project: namely the 3 Jupyter notebooks and 2 python modules: