

## CAP-6610 HW 2

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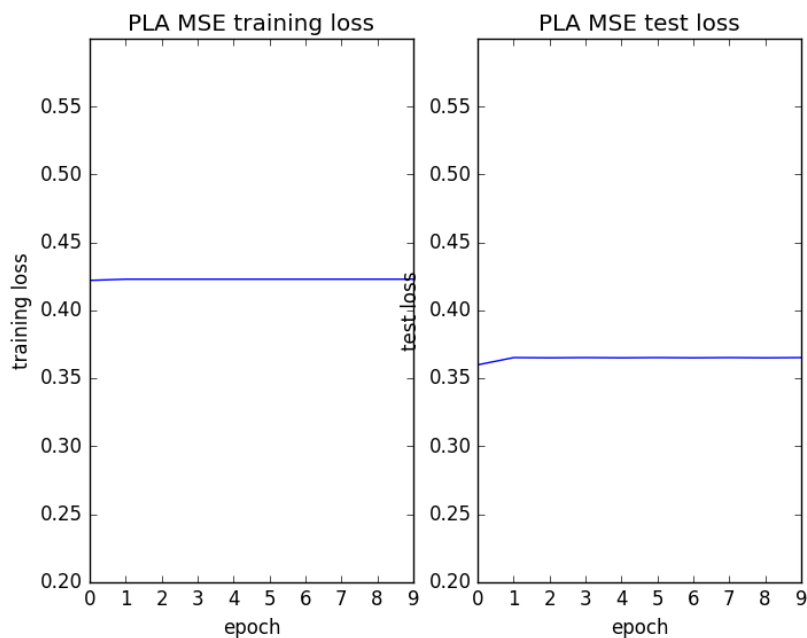
### Perceptron Learning Algorithm

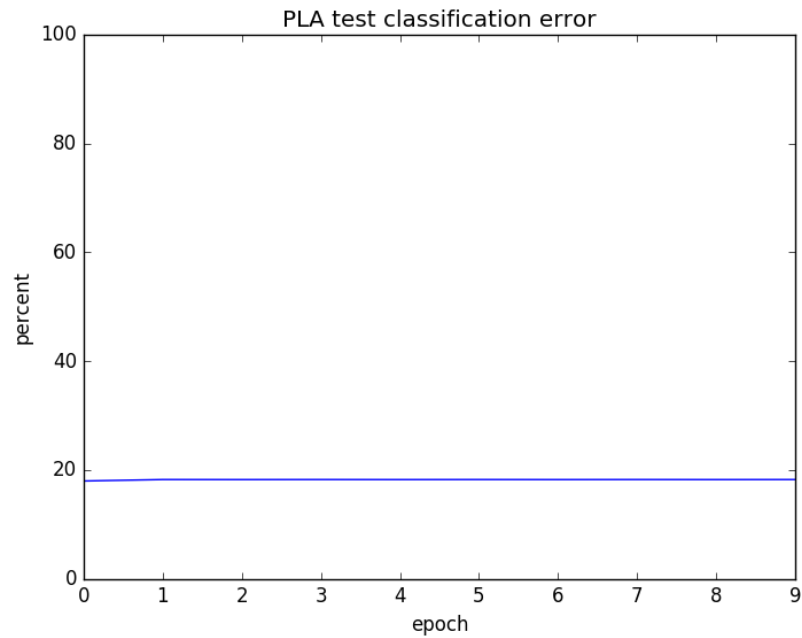
Run with `pla.py --model PLA --n_epochs 10`

On the Bank Marketing Data Set, using 10% of the data, PLA achieves a classification error of 18.25662 %, train MSE of 0.42282176, and test MSE of 0.36513274. Results are averaged over 5 random seeds.

The performance on the dataset is benchmarked by 2 methods.

1. Always guessing the label 1.0 (No response) achieved 11.6371681416 % classification error averaged across 5 random seeds.
2. Logistic Regression achieved 2.22123893805 % classification error averaged across 5 random seeds.

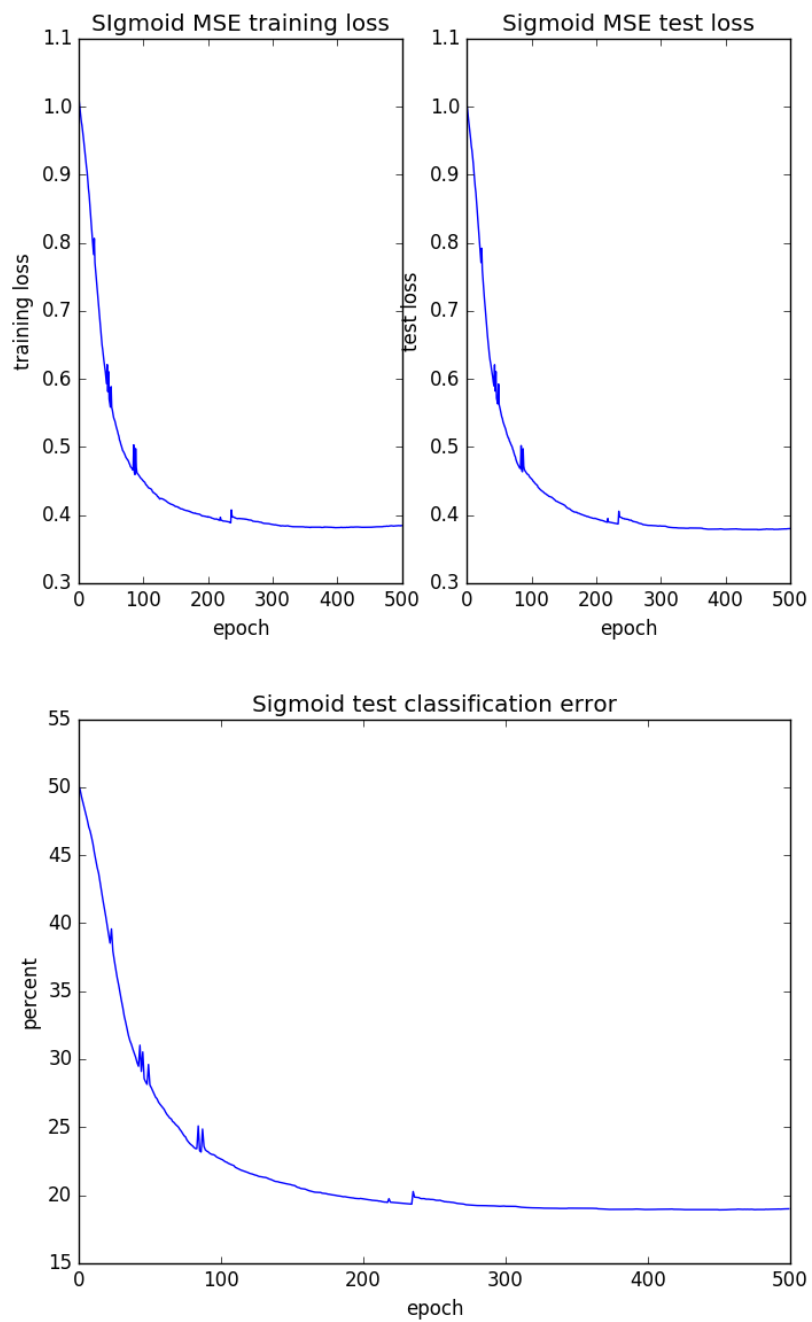




## Single-node Neural Network

Run with `pla.py --model sigmoid --learning_rate 0.1 --n_epochs 500`

On the Bank Marketing Data Set, using 10% of the data, the single-node neural net achieved a classification error of 18.99114 %, train MSE of 0.384254754533, and test MSE 0.37982300885. Results averaged over 5 random seeds.



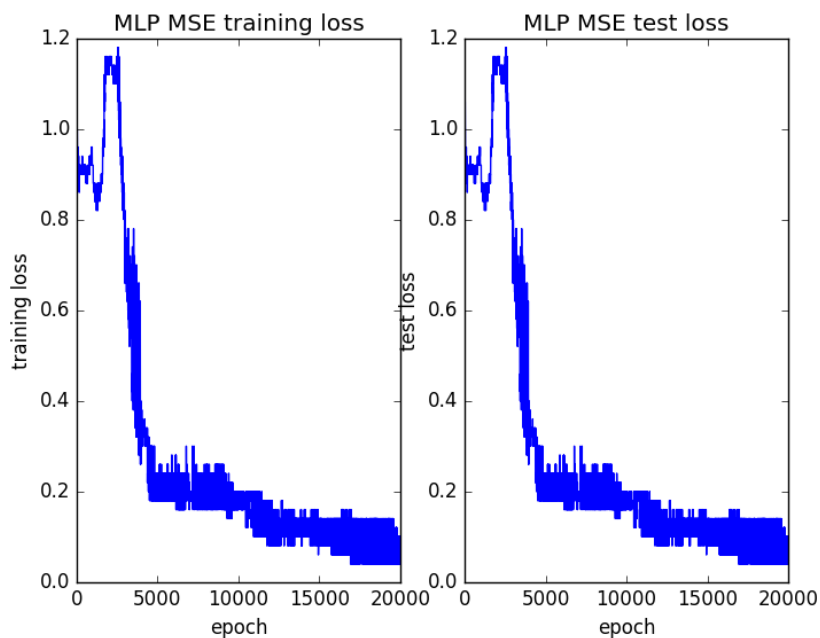
## Multi-Layer Perceptron

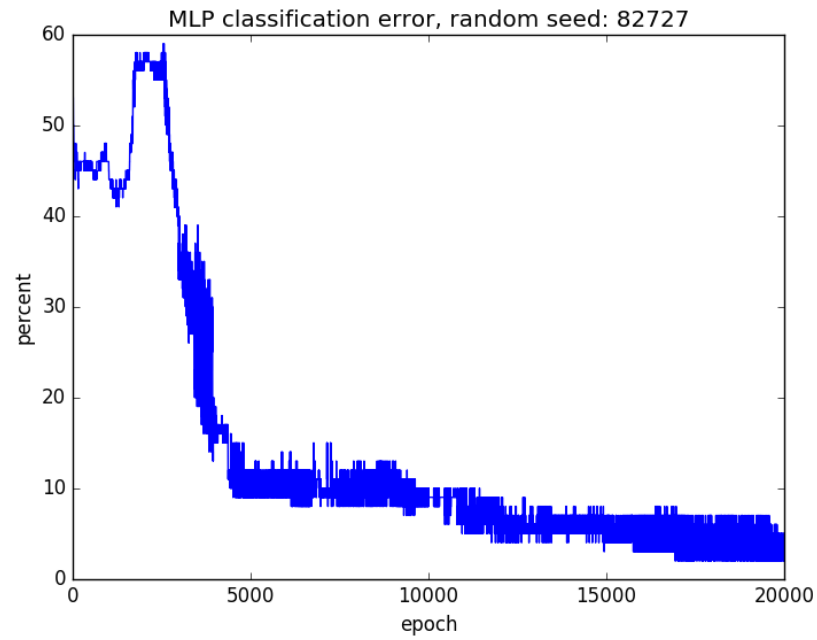
3-layer MLP with two input units, ten hidden units, and one output unit. Objective is to learn the concept of a circle in 2D space. A label of +1 is assigned if  $(x - a)^2 + (y - b)^2 < r^2$  and is labeled -1 otherwise.

All data is drawn from the unit square, and  $a = 0.5$ ,  $b = 0.6$ , and  $r = 0.4$ .

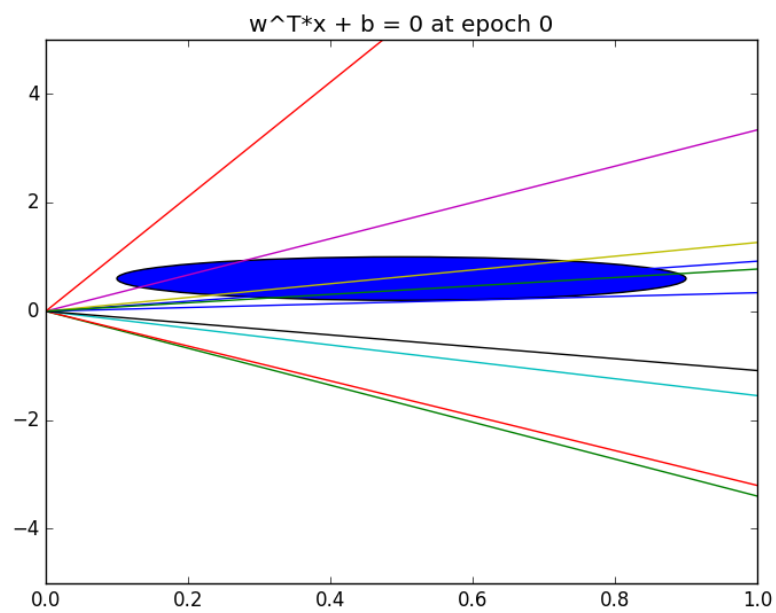
Training data is 100 random samples uniformly distributed on the unit square, and test data is 100 random samples drawn similarly.

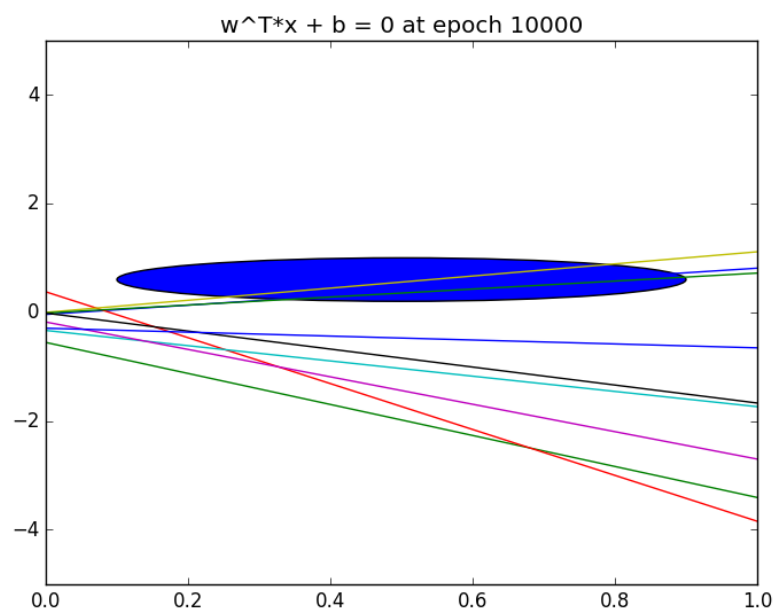
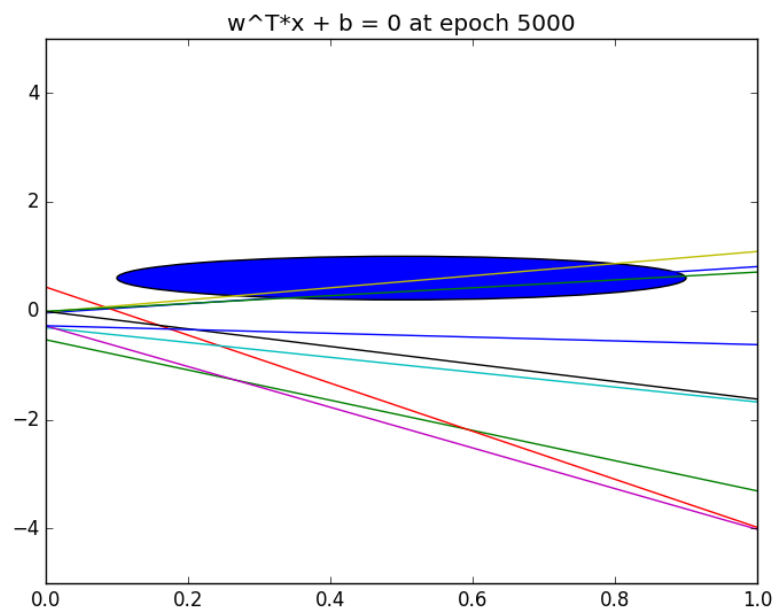
Best results over running 5 different random seeds for 20,000 epochs was a test MSE of 0.06 and a classification error of 2 %.

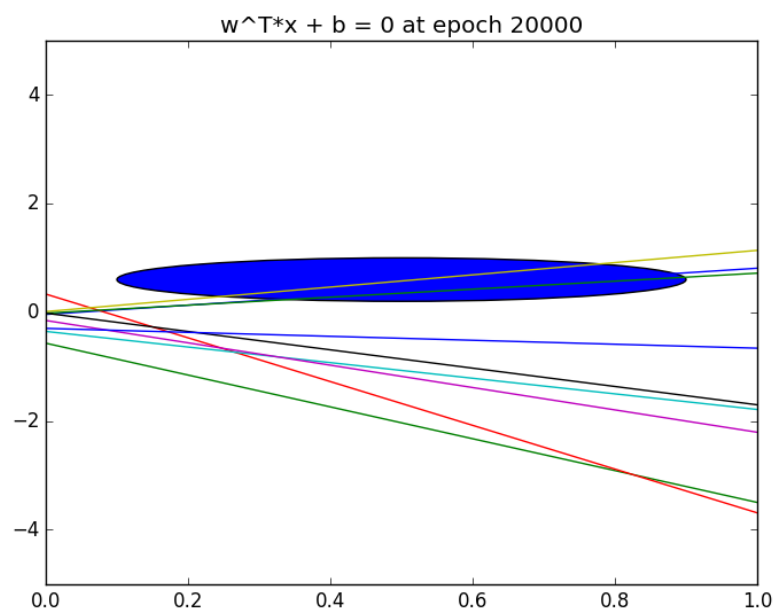
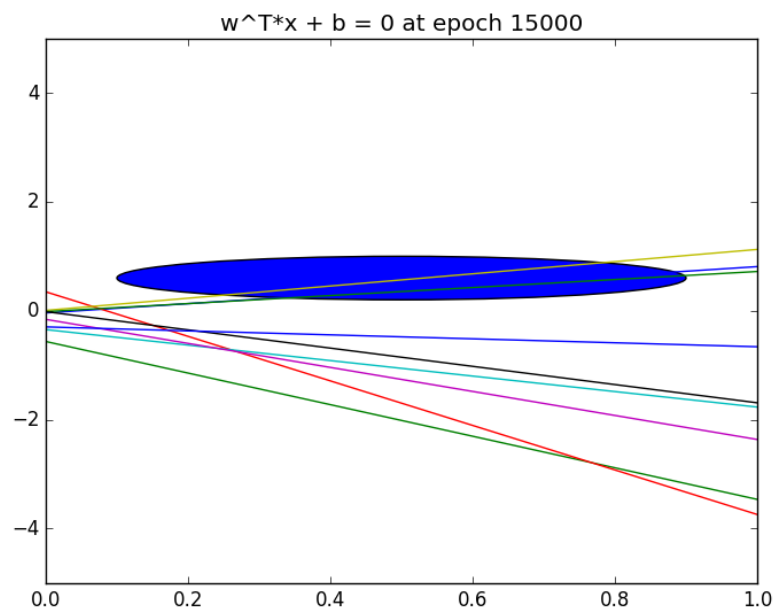




Hyperplanes  $\sum w_i x_i + b = 0$  plotted at intervals:







## Recurrent Neural-Network

Results of running 5 experiments, each with a different random seed.

Random Seed	y1 (MSE)	y2 (MSE)
23912	0.0008	0.0001
72938	0.0028	0.0049
9999	0.0008	0.0001
6767	0.0007	0.0002
1123	0.0009	0.0001

w1	w2	w1_hat	w2_hat	bias1	bias2
-0.08824226	1.05798196	0.56187399	-2.40338361	0.65013105	-1.24926364
-4.03109385	-0.90386201	1.6435506	-2.49336755	1.31868148	-0.46683088
-1.11172633	-0.17362505	1.77607984	-1.46465122	1.00974762	-0.51267624
1.41394524	0.46672458	-1.39501531	-1.31052867	0.15320471	-0.83057737
1.4844188	-1.55841486	-0.65509823	-0.38466215	0.01454801	0.47195181



