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CSC 246
Professor Adam Purtee

HOMEWORK 1 WRITEUP

My implementation of the perceptron algorithm works as expected on the 2 experimental datasets – on the linearSmoke one it converges after exactly 5 iterations, and on the xorSmoke one it never converges – even if I ran for 1,000,000 iterations, which takes relatively fast as it is a very small dataset, the algorithm still does not converges. I write accuracy per number of iterations into files for each dataset so as to facilitate drawing graphs. The graphs featured in this write up are drawn using Excel.

Challenge datasets take relatively long to run the perceptron algorithm on. However, for each dataset, I ran roughly 200,000 to 300,000 iterations. I also write the function calculate_R to calculate the bound of magnitude of vectors in the dataset, which is printed as the first line when the program is promted to run. When you run my program, if the dataset is actually linearly separable, it will print out the iteration at which the perceptron algorithm halts. Remember to set parameters --iterations and --train_file.

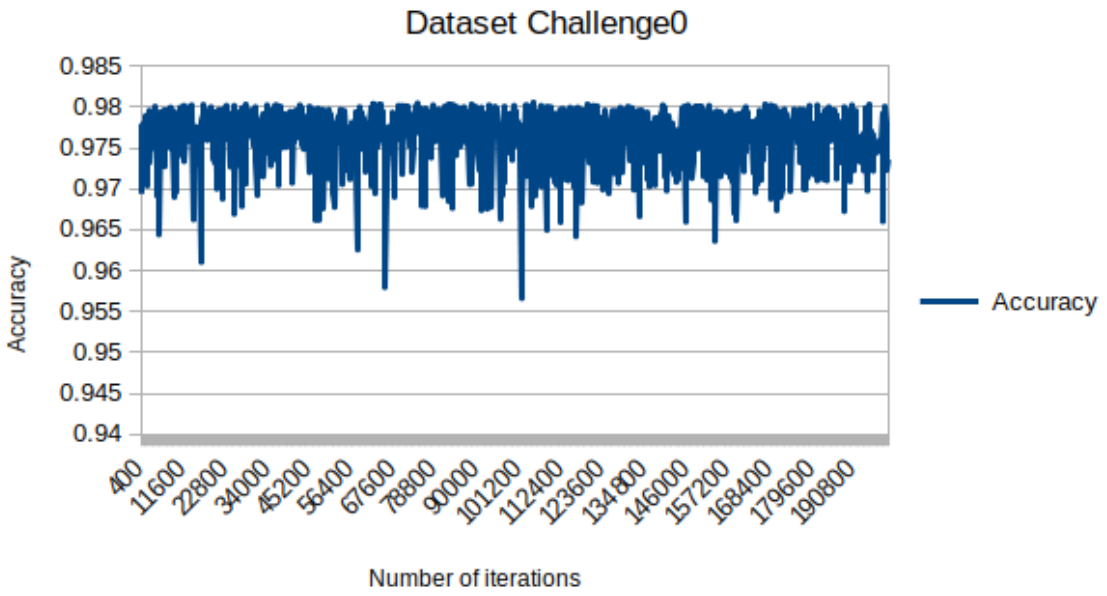
Of all the challenge datasets, I think that the 1st and the 4th one are linearly separable, and all the other are not. Here is a more detailed analysis of the algorithm running on each challenge dataset.

NOTE: I asked the professor whether it's acceptable to just report the peak accuracy and corresponding iterations without marking on the training plot, and he said it is OK.

Another important NOTE: please input the argument for the parameters --train_file when you test my code on different datasets

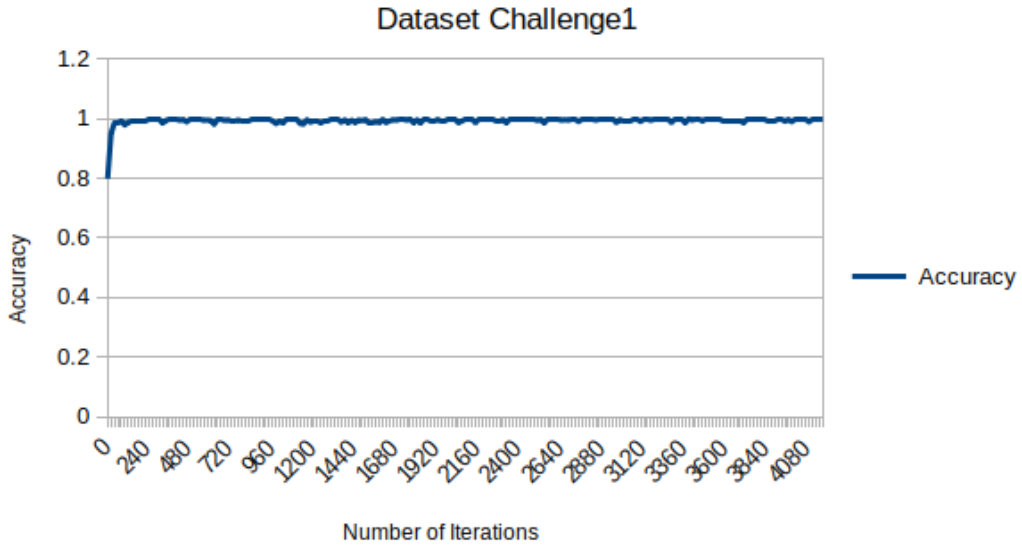
Dataset Challenge0:

- This dataset is NOT linearly separable.
- Below is a graph lablled 'Dataset Challenge0', which is a plot of accuracy per iteration (sparse number of iterations) until the maximum number of iterations I tested. The maximum accuracy I attained after training for 200,000 iterations is 0.98055, and it occurs at the 105,000th iteration.
- I think it is not separable as I have been training the perceptron algorithm for a lot of iterations (it took my a couple of hours to run this many iterations too), but the accuracy does not improve – it fluctuates around 0.97 to 0.98, and never actually reaches 1.0. I think 200,000 iterations is enough to conclude that this dataset is indeed linearly non-separable.



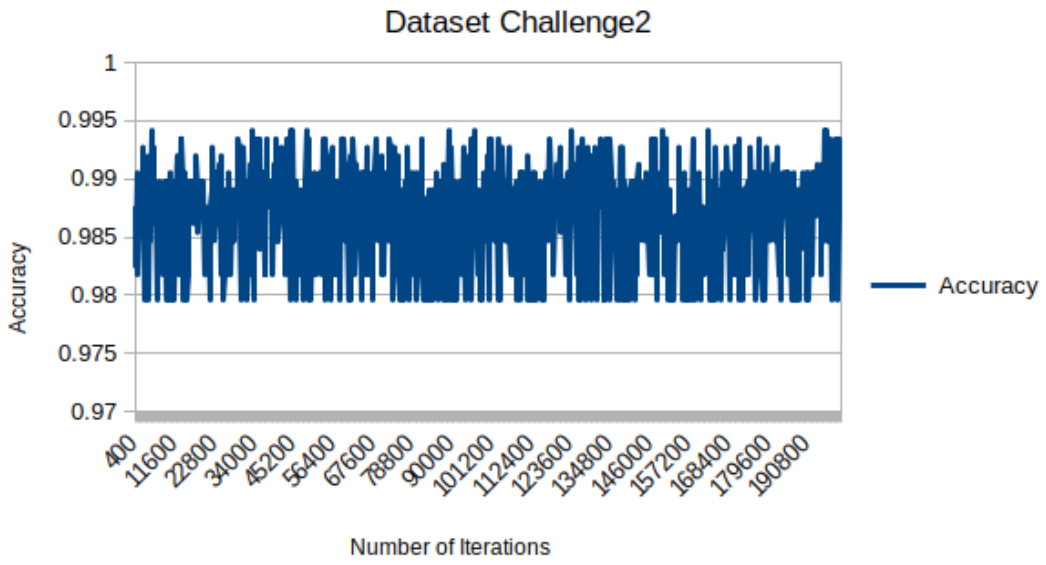
Dataset Challenge1:

- This dataset is linearly separable. This is because the perceptron algorithm stops and achieve 100% accuracy at the 4155th iteration.
- Below is a graph labelled 'Dataset Challenge1', which is a plot of accuracy per iteration (sparse number of iterations) until convergence. Here we can see that the accuracy starts at roughly 0.8 at the start of the run, the quickly goes up then plateau after the first hundred iterations. Note that here the accuracy fluctuates by very small amount below 1, but never reaches 1 before the iteration when the convergence happens. To see more details about the exact accuracy figures, check my challenge1.txt file, which is output after running the algorithm on dataset Challenge1.
- By the perceptron convergence algorithm, $k < R^2/\delta^2$. The maximum magnitude of the input vectors is $R = 4.143379$. Additionally, $k = 4155$ because the algorithm converges at the 4155th iteration. Thus $4155 < 17.167589/\delta^2$ so $0 < \delta < 0.06427$



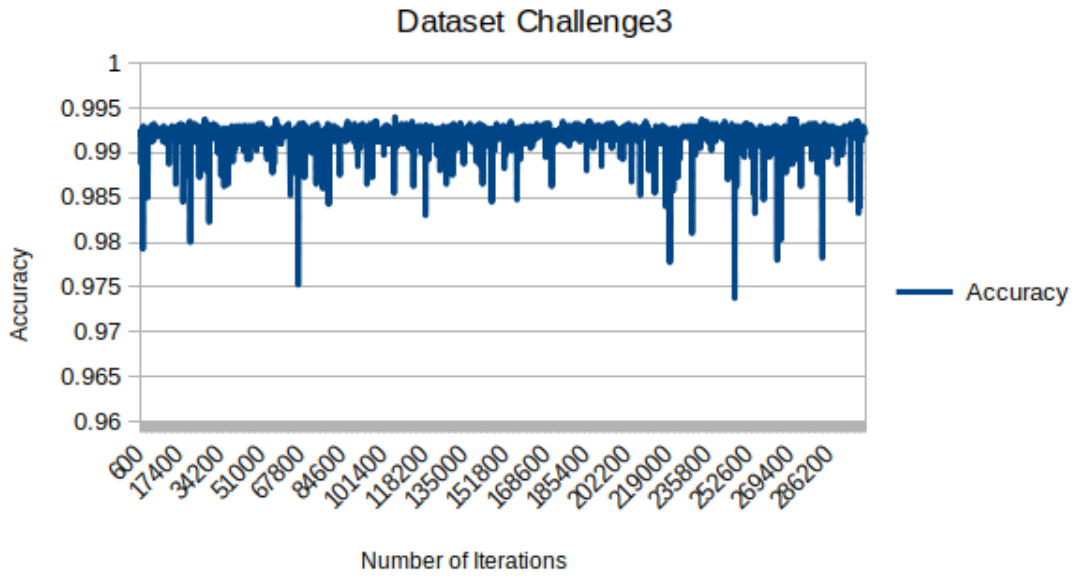
Dataset Challenge2:

- This dataset is NOT linearly separable.
- Below is a graph lablled ‘Dataset Challenge2’, which is a plot of accuracy per iteration (sparse number of iterations) until the maximum number of iterations I tested. The maximum accuracy I attained after training for 200,000 iterations is 0.9941691, and it occurs at multiple iterations: 4,800; 33,400; 44,200; 44,800; 48,600; 89,000; 96,200; 123,800; 149,600; 162,600; 195,400; 195,600; 196,000.
- I think it is not separable as I have been training the perceptron algorithm for a lot of iterations, but the accuracy does not improve – it fluctuates around 0.98 to 0.995, and never actually reaches 1.0. I think 200,000 iterations is enough to conclude that this dataset is indeed linearly non-separable.



Dataset Challenge3:

- This dataset is NOT linearly separable.
- Below is a graph lablled ‘Dataset Challenge3’, which is a plot of accuracy per iteration (sparse number of iterations) until the maximum number of iterations I tested. The maximum accuracy I attained after training for 300,000 iterations is 0.994, and it occurs at the 105,600th iteration.
- I think it is not separable as I have been training the perceptron algorithm for a lot of iterations, but the accuracy does not improve – it fluctuates around 0.98 to 0.99, and never actually reaches 1.0. I think 300,000 iterations is enough to conclude that this dataset is indeed linearly non-separable.



Dataset Challenge4:

- This dataset is linearly separable. This is because the perceptron algorithm stops and achieve 100% accuracy at the 136,694th iteration.
- Below is a graph labelled 'Dataset Challenge4', which is a plot of accuracy per iteration (sparse number of iterations) until convergence.
- By the perceptron convergence algorithm, $k < R^2/\delta^2$. The maximum magnitude of the input vectors is $R = 4.05347$. Additionally, $k = 136{,}694$ because the algorithm converges at the 136,694th iteration. Thus $136{,}694 < 16.43061/\delta^2$ so $0 < \delta < 0.0109635$.