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Project 4b

Analysis: Document has analysis for Q5, Q6, Q7, and Q8

Q5 Analysis

Pen Data

- Average Accuracy: 0.8974842767295599
- Max Accuracy: 0.9059462550028587
- St Dev Accuracy: 0.006439802436389388
- Accuracy Results from 5 iterations: [0.8956546598056032, 0.9039451114922813, 0.8893653516295026, 0.9059462550028587, 0.8925100057175529]

Car Data

- Average Accuracy: ', 0.843455497382199
- Max Accuracy: ', 0.8599476439790575
- St Dev Accuracy: ', 0.015550046711908096
- Accuracy Results from 5 iterations: [0.831151832460733, 0.8599476439790575, 0.8553664921465969, 0.8514397905759162, 0.819371727748691]

The pen data had an average accuracy of 89.75% while the car data had an average accuracy of 86%. The pen data had 24 perceptrons in the hidden later, while the car data had 16 perceptrons in the hidden layer. Both were run with a maximum of 200 iterations. The raw results are in q5_output.txt in the files submitted.

Q6 Analysis

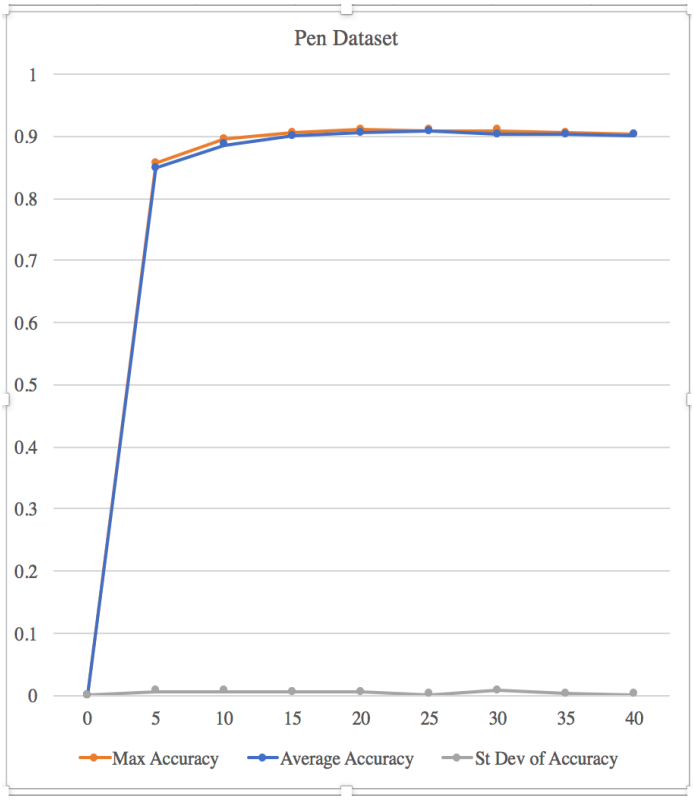
Car Dataset Results

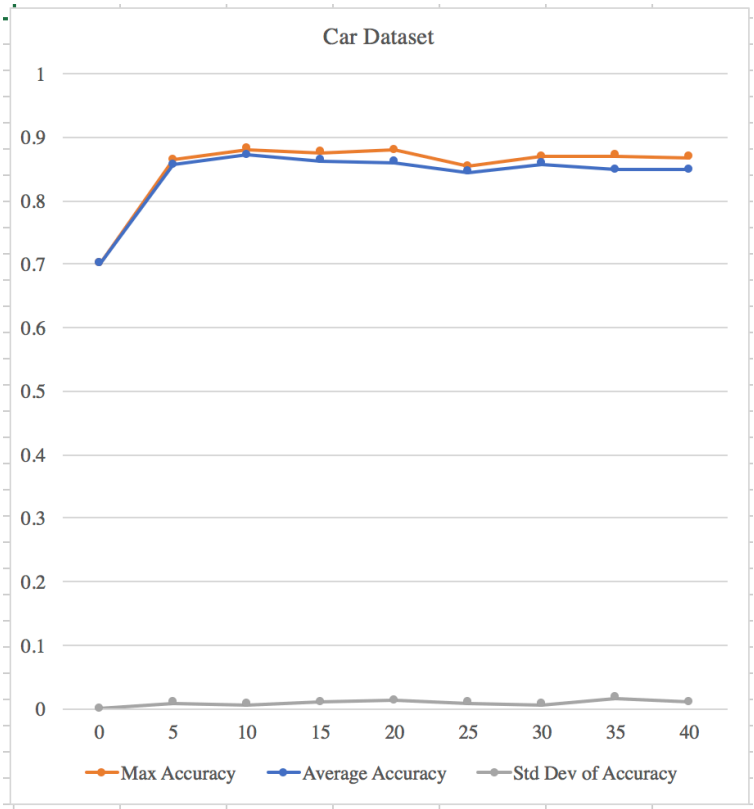
Number of Perceptrons	Max Accuracy	Average Accuracy	St Dev Accuracy
0	0.70026178	0.70026178	0
5	0.864528796	0.855890052	0.00851691
10	0.881544503	0.871335079	0.006258133
15	0.876308901	0.862696335	0.010693004
20	0.880235602	0.859816754	0.012564082
25	0.853403141	0.844895288	0.008482645
30	0.869109948	0.857460733	0.006653542
35	0.871073298	0.848298429	0.016815169
40	0.867801047	0.848560209	0.009791416

Pen Dataset Results

Number of Perceptrons	Max Accuracy	Average Accuracy	St Dev Accuracy
0	0	0	0
5	0.8567753	0.848313322	0.006764133
10	0.895368782	0.885877644	0.005904325
15	0.905088622	0.900743282	0.004712734
20	0.910520297	0.904917095	0.004866978
25	0.909090909	0.907604345	0.000911228
30	0.909948542	0.903544883	0.007133435
35	0.9053745	0.902801601	0.00268177
40	0.903373356	0.902001144	0.001177316

For the Car dataset, a hidden layer with no perceptrons resulted in 70% average accuracy. For the Pen dataset, a hidden layer with no perceptrons has 0% accuracy. These are the lowest for both datasets. Once the number of perceptrons is increased to 5, there is a dramatic increase. For Car, as the number of perceptrons increase the accuracy increases until the number of perceptrons is 15. After that there is a decrease, probably because too many perceptrons in the hidden layer do not help the model generalize well. For Pen, the accuracy increases until the number of perceptrons in the hidden layer if 15. After that the accuracy is approximately 90% regardless of how many perceptrons are added. At 35 and 40 perceptrons, there is a slight decrease for both the Pen and Car datasets. This indicates that there should be a balance for the number of nodes in the hidden layer. The raw results are in q6_output.txt in the files submitted.





Q7 Analysis

For the XOR data, the XORData.txt dataset in the datasets folder was used. Because the classifier only needs to predict the XOR function, this was used as the training and testing dataset. The original setting of the Neural Networks was 200 iterations. I started with 1 perceptron in the hidden layer, and I kept increasing it until 50. I could obtain an accuracy of 100% at approximately 47 perceptrons. The results are shown in the table below. The raw inputs (q7_output.txt) are included in the files submitted.

Num of Perceptrons in Hidden Layer	Max Accuracy	Average Accuracy	St Dev of Accuracy
0	0.5	0.4	0.2
1	0.5	0.2	0.187082869
2	0.5	0.4	0.2
3	0.5	0.35	0.2
4	0.5	0.3	0.187082869
5	0.75	0.4	0.254950976
6	0.5	0.3	0.1
7	0.75	0.4	0.2
8	0.5	0.25	0.223606798
9	0.5	0.4	0.122474487
10	0.75	0.3	0.244948974
11	0.75	0.5	0.158113883
12	0.5	0.35	0.2
13	0.75	0.45	0.244948974
14	1	0.65	0.254950976
15	0.75	0.7	0.1
16	0.75	0.55	0.1
17	1	0.5	0.316227766
18	0.75	0.4	0.254950976
19	0.75	0.45	0.187082869
20	0.5	0.25	0.158113883
21	0.75	0.55	0.187082869
22	1	0.7	0.187082869
23	0.75	0.55	0.187082869
24	1	0.7	0.187082869
25	1	0.75	0.273861279
26	0.75	0.6	0.2
27	1	0.8	0.187082869
28	1	0.8	0.1
29	1	0.8	0.187082869
30	0.75	0.65	0.122474487
31	1	0.85	0.2
32	1	0.8	0.187082869
33	1	0.7	0.187082869
34	1	0.8	0.187082869
35	0.75	0.7	0.1
36	1	0.8	0.187082869
37	1	0.75	0.273861279
38	0.75	0.75	0
39	1	0.8	0.187082869
40	1	0.8	0.187082869
41	1	0.8	0.244948974
42	1	0.95	0.1
43	1	0.95	0.1
44	0.75	0.7	0.1
45	1	0.8	0.187082869
46	1	0.9	0.2
47	1	1	0

I expected that more perceptrons in the hidden layer will improve the accuracy. When there were 0 perceptrons in the hidden layer, we had an average accuracy of 0.4, but it increased as more perceptrons were added in the layer.

Based on what we saw in class, the expected results are that 4 perceptrons (each attribute has 2 input perceptrons, total 2 attributes) will be needed in the hidden layer in order to train the neural network. I also noticed that the number of iterations, 200, was very low. I increased the maximum iterations up until 5000 with a step size of 500, and I recorded the number of perceptrons at which the neural network achieved 100% accuracy. The model reaches 100% average accuracy with 4 perceptrons at 2000 max iterations.

Iterations	Perceptrons Needed in Hidden Layer to get 100% Accuracy
200	48
500	21
1000	12
1500	4
2000	4

Q8 Analysis

Extra Credit Dataset

The dataset chosen is a Tic Tac Toe dataset (https://archive.ics.uci.edu/ml/datasets/Tic-Tac-Toe+Endgame). The raw output is included in the q8_output.txt file submitted.

- Average Accuracy: 0.972823218997
- Max Accuracy: 0.982849604222
- St Dev: 0.0104413503627
- Accuracy Results from 5 iterations: [0.982850, 0.957784, 0.963061, 0.977573, 0.982850]