MLFA Assignment 5 - REPORT
Feed-Forward Neural-Net

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OUTPUT AND RESULTS :

1. CASE - 1 : Compute accuracy on the MNIST test data for each of the model with different number of hidden layers

Training model with 2 number of hidden layers :

Hidden Layers: 2, Iteration: 100, Loss: 1.4419004917144775, Percentage Accuracy: 59.06 %
Hidden Layers: 2, Iteration: 200, Loss: 1.1326314210891724, Percentage Accuracy: 73.56 %
Hidden Layers: 2, Iteration: 300, Loss: 0.8816784620285034, Percentage Accuracy: 79.14 %
Hidden Layers: 2, Iteration: 400, Loss: 0.7708246111869812, Percentage Accuracy: 82.4 %
Hidden Layers: 2, Iteration: 500, Loss: 0.723793089389801, Percentage Accuracy: 84.6 %
Hidden Layers: 2, Iteration: 600, Loss: 0.5334466695785522, Percentage Accuracy: 86.19 %
Hidden Layers: 2, Iteration: 700, Loss: 0.5593057870864868, Percentage Accuracy: 87.16 %
Hidden Layers: 2, Iteration: 800, Loss: 0.3669230341911316, Percentage Accuracy: 87.89 %
Hidden Layers: 2, Iteration: 900, Loss: 0.41776204109191895, Percentage Accuracy: 88.69 %
Hidden Layers: 2, Iteration: 1000, Loss: 0.46741822361946106, Percentage Accuracy: 89.0 %
Hidden Layers: 2, Iteration: 1100, Loss: 0.46013230085372925, Percentage Accuracy: 89.57 %
Hidden Layers: 2, Iteration: 1200, Loss: 0.5177156329154968, Percentage Accuracy: 90.1 %
Hidden Layers: 2, Iteration: 1300, Loss: 0.4282878637313843, Percentage Accuracy: 90.37 %

Hidden Layers: 2, Iteration: 1400, Loss: 0.32398995757102966, Percentage Accuracy: 90.66 %

Hidden Layers: 2, Iteration: 1500, Loss: 0.46426936984062195, Percentage Accuracy: 90.94 %

Hidden Layers: 2, Iteration: 1600, Loss: 0.3289739191532135, Percentage Accuracy: 91.18 %

Hidden Layers: 2, Iteration: 1700, Loss: 0.29395735263824463, Percentage Accuracy: 91.22 %

Hidden Layers: 2, Iteration: 1800, Loss: 0.37895506620407104, Percentage Accuracy: 91.46 %

Hidden Layers: 2, Iteration: 1900, Loss: 0.341206431388855, Percentage Accuracy: 91.53 %

Hidden Layers: 2, Iteration: 2000, Loss: 0.383555144071579, Percentage Accuracy: 91.62 %

Hidden Layers: 2, Iteration: 2100, Loss: 0.36494380235671997, Percentage Accuracy: 91.87 %

Hidden Layers: 2, Iteration: 2200, Loss: 0.40099841356277466, Percentage Accuracy: 91.89 %

Hidden Layers: 2, Iteration: 2300, Loss: 0.29268425703048706, Percentage Accuracy: 91.99 %

Hidden Layers: 2, Iteration: 2400, Loss: 0.2389601171016693, Percentage Accuracy: 92.2 %

Hidden Layers: 2, Iteration: 2500, Loss: 0.33811911940574646, Percentage Accuracy: 92.29 %

Hidden Layers: 2, Iteration: 2600, Loss: 0.16644850373268127, Percentage Accuracy: 92.48 %

Hidden Layers: 2, Iteration: 2700, Loss: 0.2675198018550873, Percentage Accuracy: 92.67 %

Hidden Layers: 2, Iteration: 2800, Loss: 0.27358880639076233, Percentage Accuracy: 92.62 %

Hidden Layers: 2, Iteration: 2900, Loss: 0.29652470350265503, Percentage Accuracy: 92.74 %

Hidden Layers: 2, Iteration: 3000, Loss: 0.2888285517692566, Percentage Accuracy: 92.8 %

Hidden Layers: 2, Iteration: 3100, Loss: 0.18110936880111694, Percentage Accuracy: 92.86 %

Hidden Layers: 2, Iteration: 3200, Loss: 0.21805568039417267, Percentage Accuracy: 93.06 %

Hidden Layers: 2, Iteration: 3300, Loss: 0.27960399879322052, Percentage Accuracy: 93.15 %

Hidden Layers: 2, Iteration: 3400, Loss: 0.2421846240758896, Percentage Accuracy: 93.1 %
Hidden Layers: 2, Iteration: 3500, Loss: 0.29555752873420715, Percentage Accuracy: 93.17 %
Hidden Layers: 2, Iteration: 3600, Loss: 0.28678596019744873, Percentage Accuracy: 93.1 %

Accuracy of the fully trained model (i.e. after 3600 iterations = 6 epochs), with 2 hidden layers, on the test data : 93.10%

Training model with 4 number of hidden layers :

Hidden Layers: 4, Iteration: 100, Loss: 1.4692012071609497, Percentage Accuracy: 63.81 %
Hidden Layers: 4, Iteration: 200, Loss: 0.9900546073913574, Percentage Accuracy: 77.47 %
Hidden Layers: 4, Iteration: 300, Loss: 0.8036264777183533, Percentage Accuracy: 83.69 %
Hidden Layers: 4, Iteration: 400, Loss: 0.6392833590507507, Percentage Accuracy: 86.4 %
Hidden Layers: 4, Iteration: 500, Loss: 0.5859763622283936, Percentage Accuracy: 87.93 %
Hidden Layers: 4, Iteration: 600, Loss: 0.5277850031852722, Percentage Accuracy: 88.7 %
Hidden Layers: 4, Iteration: 700, Loss: 0.4773198366165161, Percentage Accuracy: 89.39 %
Hidden Layers: 4, Iteration: 800, Loss: 0.35900089144706726, Percentage Accuracy: 89.75 %
Hidden Layers: 4, Iteration: 900, Loss: 0.3925734758377075, Percentage Accuracy: 90.22 %
Hidden Layers: 4, Iteration: 1000, Loss: 0.5031192898750305, Percentage Accuracy: 90.67 %
Hidden Layers: 4, Iteration: 1100, Loss: 0.46476736664772034, Percentage Accuracy: 90.99 %
Hidden Layers: 4, Iteration: 1200, Loss: 0.3841712176799774, Percentage Accuracy: 91.17 %
Hidden Layers: 4, Iteration: 1300, Loss: 0.3306858539581299, Percentage Accuracy: 91.34 %
Hidden Layers: 4, Iteration: 1400, Loss: 0.2877280116081238, Percentage Accuracy: 91.51 %

Hidden Layers: 4, Iteration: 1500, Loss: 0.39498424530029297, Percentage Accuracy: 91.77 %

Hidden Layers: 4, Iteration: 1600, Loss: 0.4379229247570038, Percentage Accuracy: 91.9 %

Hidden Layers: 4, Iteration: 1700, Loss: 0.35407039523124695, Percentage Accuracy: 92.06 %

Hidden Layers: 4, Iteration: 1800, Loss: 0.35900238156318665, Percentage Accuracy: 92.41 %

Hidden Layers: 4, Iteration: 1900, Loss: 0.39099636673927307, Percentage Accuracy: 92.53 %

Hidden Layers: 4, Iteration: 2000, Loss: 0.2570827007293701, Percentage Accuracy: 92.59 %

Hidden Layers: 4, Iteration: 2100, Loss: 0.18498767912387848, Percentage Accuracy: 92.67 %

Hidden Layers: 4, Iteration: 2200, Loss: 0.3248397707939148, Percentage Accuracy: 92.81 %

Hidden Layers: 4, Iteration: 2300, Loss: 0.3528640866279602, Percentage Accuracy: 92.87 %

Hidden Layers: 4, Iteration: 2400, Loss: 0.22528652846813202, Percentage Accuracy: 93.01 %

Hidden Layers: 4, Iteration: 2500, Loss: 0.22389709949493408, Percentage Accuracy: 93.15 %

Hidden Layers: 4, Iteration: 2600, Loss: 0.23333381116390228, Percentage Accuracy: 93.13 %

Hidden Layers: 4, Iteration: 2700, Loss: 0.3231787085533142, Percentage Accuracy: 93.28 %

Hidden Layers: 4, Iteration: 2800, Loss: 0.2005126029253006, Percentage Accuracy: 93.14 %

Hidden Layers: 4, Iteration: 2900, Loss: 0.14844867587089539, Percentage Accuracy: 93.36 %

Hidden Layers: 4, Iteration: 3000, Loss: 0.2233484983444214, Percentage Accuracy: 93.46 %

Hidden Layers: 4, Iteration: 3100, Loss: 0.11940475553274155, Percentage Accuracy: 93.48 %

Hidden Layers: 4, Iteration: 3200, Loss: 0.20556184649467468, Percentage Accuracy: 93.79 %

Hidden Layers: 4, Iteration: 3300, Loss: 0.1618761122226715, Percentage Accuracy: 93.68 %

Hidden Layers: 4, Iteration: 3400, Loss: 0.12172720581293106, Percentage Accuracy: 93.83 %

Hidden Layers: 4, Iteration: 3500, Loss: 0.2553698420524597, Percentage Accuracy: 93.94 %

Hidden Layers: 4, Iteration: 3600, Loss: 0.24733354151248932, Percentage Accuracy: 93.97 %

Accuracy of the fully trained model (i.e. after 3600 iterations = 6 epochs), with 4 hidden layers, on the test data : 93.97%

Training model with 8 number of hidden layers :

Hidden Layers: 8, Iteration: 100, Loss: 1.4649784564971924, Percentage Accuracy: 60.45 %

Hidden Layers: 8, Iteration: 200, Loss: 1.0034229755401611, Percentage Accuracy: 76.85 %

Hidden Layers: 8, Iteration: 300, Loss: 0.7319455146789551, Percentage Accuracy: 83.57 %

Hidden Layers: 8, Iteration: 400, Loss: 0.7706396579742432, Percentage Accuracy: 86.85 %

Hidden Layers: 8, Iteration: 500, Loss: 0.5883097052574158, Percentage Accuracy: 88.49 %

Hidden Layers: 8, Iteration: 600, Loss: 0.4273597002029419, Percentage Accuracy: 89.55 %

Hidden Layers: 8, Iteration: 700, Loss: 0.38878268003463745, Percentage Accuracy: 90.25 %

Hidden Layers: 8, Iteration: 800, Loss: 0.28521206974983215, Percentage Accuracy: 90.86 %

Hidden Layers: 8, Iteration: 900, Loss: 0.26695287227630615, Percentage Accuracy: 91.25 %

Hidden Layers: 8, Iteration: 1000, Loss: 0.21488848328590393, Percentage Accuracy: 91.62 %

Hidden Layers: 8, Iteration: 1100, Loss: 0.226674422621727, Percentage Accuracy: 92.03 %

Hidden Layers: 8, Iteration: 1200, Loss: 0.42561832070350647, Percentage Accuracy: 92.31 %

Hidden Layers: 8, Iteration: 1300, Loss: 0.3388809859752655, Percentage Accuracy: 92.69 %

Hidden Layers: 8, Iteration: 1400, Loss: 0.23858927190303802, Percentage Accuracy: 92.86 %

Hidden Layers: 8, Iteration: 1500, Loss: 0.2934953570365906, Percentage Accuracy: 93.2 %

Hidden Layers: 8, Iteration: 1600, Loss: 0.14827898144721985, Percentage Accuracy: 93.35 %
Hidden Layers: 8, Iteration: 1700, Loss: 0.1919354498386383, Percentage Accuracy: 93.33 %
Hidden Layers: 8, Iteration: 1800, Loss: 0.2076883316040039, Percentage Accuracy: 93.67 %
Hidden Layers: 8, Iteration: 1900, Loss: 0.4270177185535431, Percentage Accuracy: 93.84 %
Hidden Layers: 8, Iteration: 2000, Loss: 0.17026089131832123, Percentage Accuracy: 93.9 %
Hidden Layers: 8, Iteration: 2100, Loss: 0.27003809809684753, Percentage Accuracy: 93.96 %
Hidden Layers: 8, Iteration: 2200, Loss: 0.21928343176841736, Percentage Accuracy: 94.17 %
Hidden Layers: 8, Iteration: 2300, Loss: 0.09526459872722626, Percentage Accuracy: 94.2 %
Hidden Layers: 8, Iteration: 2400, Loss: 0.11311350017786026, Percentage Accuracy: 94.21 %
Hidden Layers: 8, Iteration: 2500, Loss: 0.14683163166046143, Percentage Accuracy: 94.32 %
Hidden Layers: 8, Iteration: 2600, Loss: 0.22517944872379303, Percentage Accuracy: 94.38 %
Hidden Layers: 8, Iteration: 2700, Loss: 0.2691112458705902, Percentage Accuracy: 94.64 %
Hidden Layers: 8, Iteration: 2800, Loss: 0.07583838701248169, Percentage Accuracy: 94.61 %
Hidden Layers: 8, Iteration: 2900, Loss: 0.18823064863681793, Percentage Accuracy: 94.67 %
Hidden Layers: 8, Iteration: 3000, Loss: 0.21387815475463867, Percentage Accuracy: 94.72 %
Hidden Layers: 8, Iteration: 3100, Loss: 0.14479507505893707, Percentage Accuracy: 94.75 %
Hidden Layers: 8, Iteration: 3200, Loss: 0.12706169486045837, Percentage Accuracy: 94.86 %
Hidden Layers: 8, Iteration: 3300, Loss: 0.08808670192956924, Percentage Accuracy: 94.93 %
Hidden Layers: 8, Iteration: 3400, Loss: 0.29318130016326904, Percentage Accuracy: 95.03 %
Hidden Layers: 8, Iteration: 3500, Loss: 0.13850677013397217, Percentage Accuracy: 95.16 %

Hidden Layers: 8, Iteration: 3600, Loss: 0.2402515858411789, Percentage
Accuracy: 95.15 %

Accuracy of the fully trained model (i.e. after 3600 iterations = 6 epochs), with 8 hidden layers, on the test data : 95.15%

Plot of Loss VS. Iterations for models with 2 , 4, 8 hidden layers :
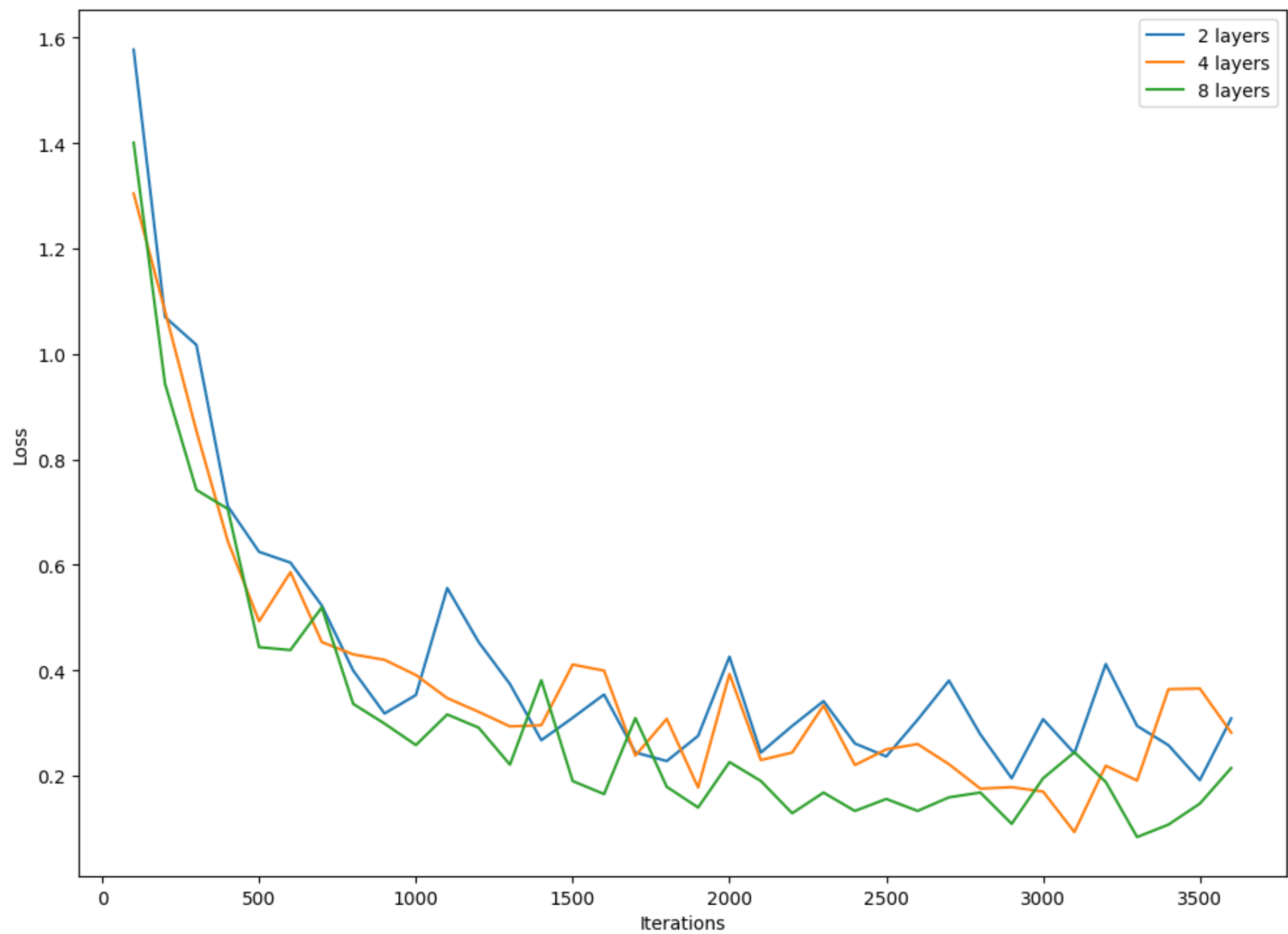
CASE - 2 : Print the layers based on their performance deviation (in descending order) after perturbing the parameters

Ranking of layers based on Performance Deviation (in descending order) for 2 hidden layers:

1. When parameters connecting from Hidden2_to_Output is perturbed, - Performance Deviation from Non-Perturbed Model is : 67.05%
2. When parameters connecting from Hidden1_to_Hidden2 is perturbed, - Performance Deviation from Non-Perturbed Model is : 50.01%
3. When parameters connecting from Input_to_Hidden1 is perturbed, - Performance Deviation from Non-Perturbed Model is : 46.31%

Ranking of layers based on Performance Deviation (in descending order) for 4 hidden layers:

1. When parameters connecting from Hidden4_to_Output is perturbed, - Performance Deviation from Non-Perturbed Model is : 72.38%
2. When parameters connecting from Hidden3_to_Hidden4 is perturbed, - Performance Deviation from Non-Perturbed Model is : 70.86%
3. When parameters connecting from Hidden2_to_Hidden3 is perturbed, - Performance Deviation from Non-Perturbed Model is : 67.58%
4. When parameters connecting from Hidden1_to_Hidden2 is perturbed, - Performance Deviation from Non-Perturbed Model is : 66.18%
5. When parameters connecting from Input_to_Hidden1 is perturbed, - Performance Deviation from Non-Perturbed Model is : 61.23%

Ranking of layers based on Performance Deviation (in descending order) for 8 hidden layers:

1. When parameters connecting from Hidden8_to_Output is perturbed, - Performance Deviation from Non-Perturbed Model is : 85.29%
2. When parameters connecting from Hidden5_to_Hidden6 is perturbed, - Performance Deviation from Non-Perturbed Model is : 85.24%
3. When parameters connecting from Hidden7_to_Hidden8 is perturbed, - Performance Deviation from Non-Perturbed Model is : 84.25%
4. When parameters connecting from Hidden6_to_Hidden7 is perturbed, - Performance Deviation from Non-Perturbed Model is : 84.12%
5. When parameters connecting from Hidden4_to_Hidden5 is perturbed, - Performance Deviation from Non-Perturbed Model is : 83.56%

6. When parameters connecting from Hidden3_to_Hidden4 is perturbed, - Performance Deviation from Non-Perturbed Model is : 80.37%

7. When parameters connecting from Hidden2_to_Hidden3 is perturbed, - Performance Deviation from Non-Perturbed Model is : 80.07%

8. When parameters connecting from Hidden1_to_Hidden2 is perturbed, - Performance Deviation from Non-Perturbed Model is : 72.55%

9. When parameters connecting from Input_to_Hidden1 is perturbed, - Performance Deviation from Non-Perturbed Model is : 70.35%