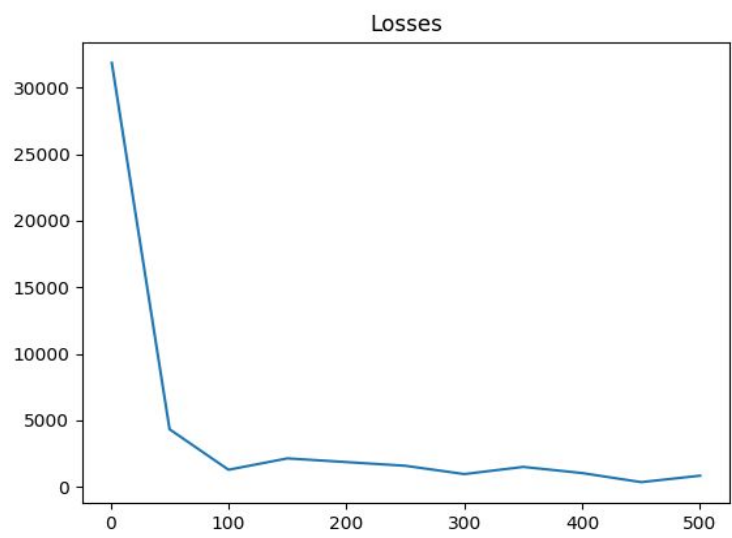


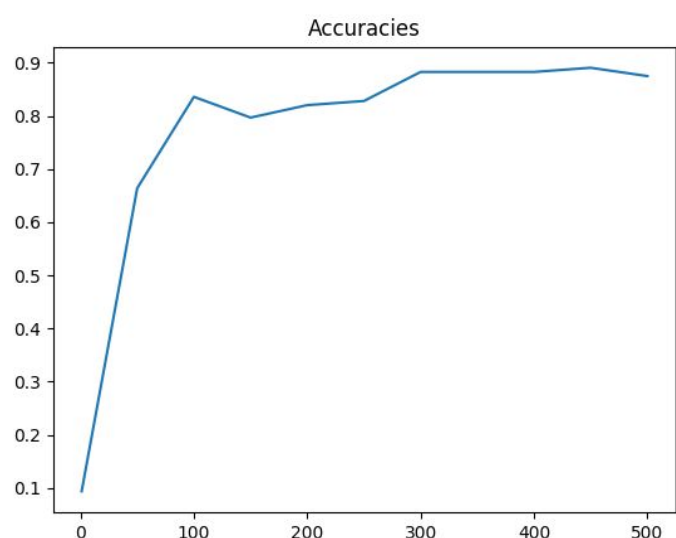
# 3 Layer API - A Simple Neural Network

On MNIST Dataset -

Learning Curves -



Losses vs Iterations



Training Accuracies vs Iterations

Testing Accuracy - 0.88

F-Scores -

Number	F-Score
0	0.92807882
1	0.94200351
2	0.85492479
3	0.85437882
4	0.87028074
5	0.80493827
6	0.09132888
7	0.89975062
8	0.79848268
9	0.83020833

Confusion Matrices -

942	0	1	3	0	5	21	2	1	5
0	1072	21	4	0	1	3	1	33	0
23	16	881	26	9	5	10	10	48	4
5	7	40	839	1	28	2	9	61	18
4	3	10	1	899	0	28	3	9	25
27	3	7	45	20	652	21	7	102	8
18	2	12	2	14	6	890	1	12	1
5	12	39	9	14	0	0	902	9	38
15	17	16	12	13	27	12	5	842	15

11      9      2      13    114      4      4      37      18    797

### Variations Tried -

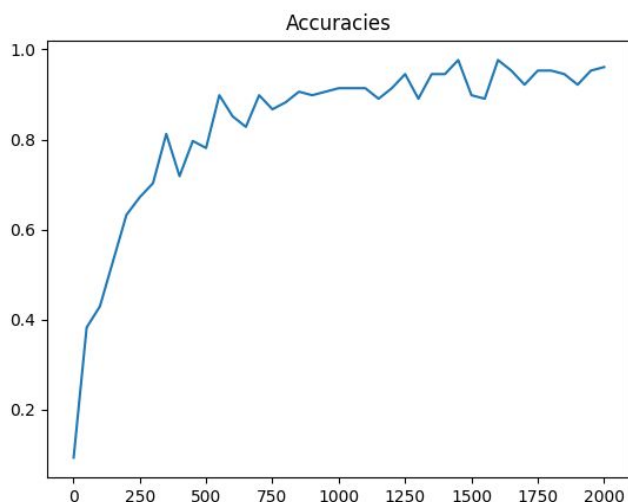
- 1) One hidden layer with 256 nodes this gave - 'Testing Accuracy:', 0.87
- 2) 3 hidden layers with 512, 256, 128 neurons respectively with 1000 epochs gave - Testing Accuracy 88.1
- 3) Changed Alpha to 0.001 and initializers to truncated\_normal gave accuracy 0.8818
- 4) Use GradientDescentOptimizer - Terrible performance!

### Inference -

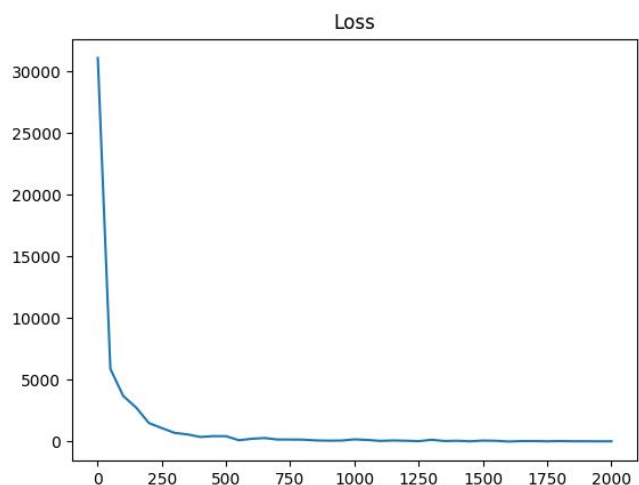
The model overall performs well and learns different features of digits. It however is sometimes unable to distinguish between two similar digits which are spatially different but have same features. For instance number 9 and 4, which many people write similarly - with a loop on top and a vertical line, hence the model is confused in these case. Similar is the case with 5 and 8, which in human written form has similar curves that is like an S and so the model sometimes misclassified this. In most other cases it performs well.

### On Q1 Dataset -

### Learning Curves -



Training Accuracy vs Iterations



Loss vs Iteration

### Testing Accuracy - 0.772

### Confusion Matrix -

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# **F-Scores -**

[0.3908046 , 0.91176471, 0.7244898 , 0.99502488, 0.37563452,  
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 0.8 , 0.99009901, 0.5 , 0.79792746, 0.89690722,  
 0.97 , 0.46601942, 0.83417085, 0.82568807, 1. ,  
 0.32352941, 0.85714286, 0.72277228, 0.97487437, 0.5078125 ,  
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0.98019802, 0.50485437, 0.78181818, 0.8342246 , 0.98989899,  
0.31707317, 0.79787234, 0.85581395, 0.98 , 0.31336406,  
0.86294416, 0.77272727, 0.99497487, 0.52212389, 0.95522388,  
0.82296651, 0.99497487, 0.32535885, 0.95477387, 0.82191781,  
0.99 , 0.43946188, 0.93264249, 0.85714286, 0.99009901,  
0.52910053, 0.86829268, 0.93137255, 0.98522167, 0.40462428,  
0.88442211, 0.88557214, 0.98477157, 0.31967213, 0.8989899 ,  
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0.89756098, 0.99502488, 0.29508197, 0.93401015, 0.77777778,  
1. ]

**Variations Tried** - Numerous variations tried with hidden layers. Anything less than two layers gave dismal performance. Variation also done with different optimizers like Adam, RMSProp, AdamAda. GradientDescent gave best performance. Experimented with batch size- Batch\_sizes above 128 gave poor performance. Also training without shuffling gave very dismal performance, performance improved drastically by shuffling. Added regularizer to reduce overfitting. Use of activation layers - Adding ReLu to the first hidden layer improves accuracy drastically, almost doubling it.

#### **Inferences -**

The network easily overfits due to less amount of training data as excessive training data results in MemoryError. ReLu activation function helps it to discard certain redundant input data. Also the network finds it difficult to distinguish between similar classes like short length with same width but 15 degrees apart as in JPG images the pixels are not much separated and are actually like two shorter lines. This causes the network to confuse between these two. The network however is easily able to distinguish between two different colours and doesn't make an error in it. There is also sometime confusion in cases of same length and different width. Network gets confused in such distinct classes -

