Assignment I
Neural Networks and Genetic Algorithms
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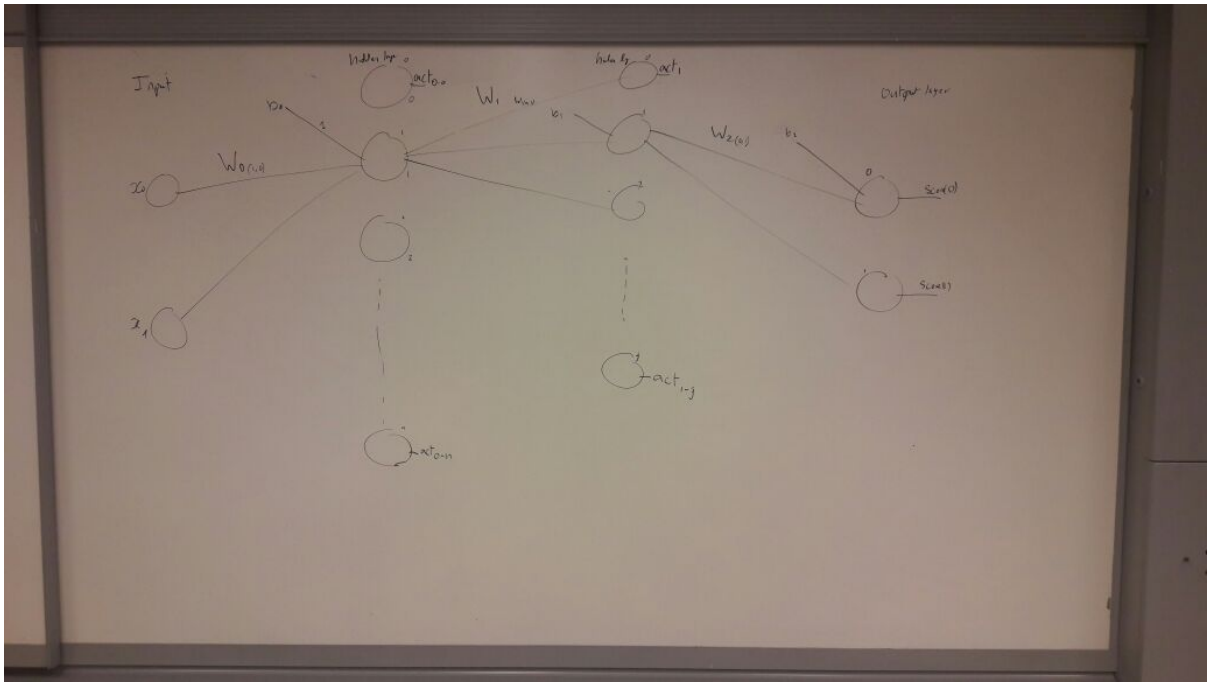
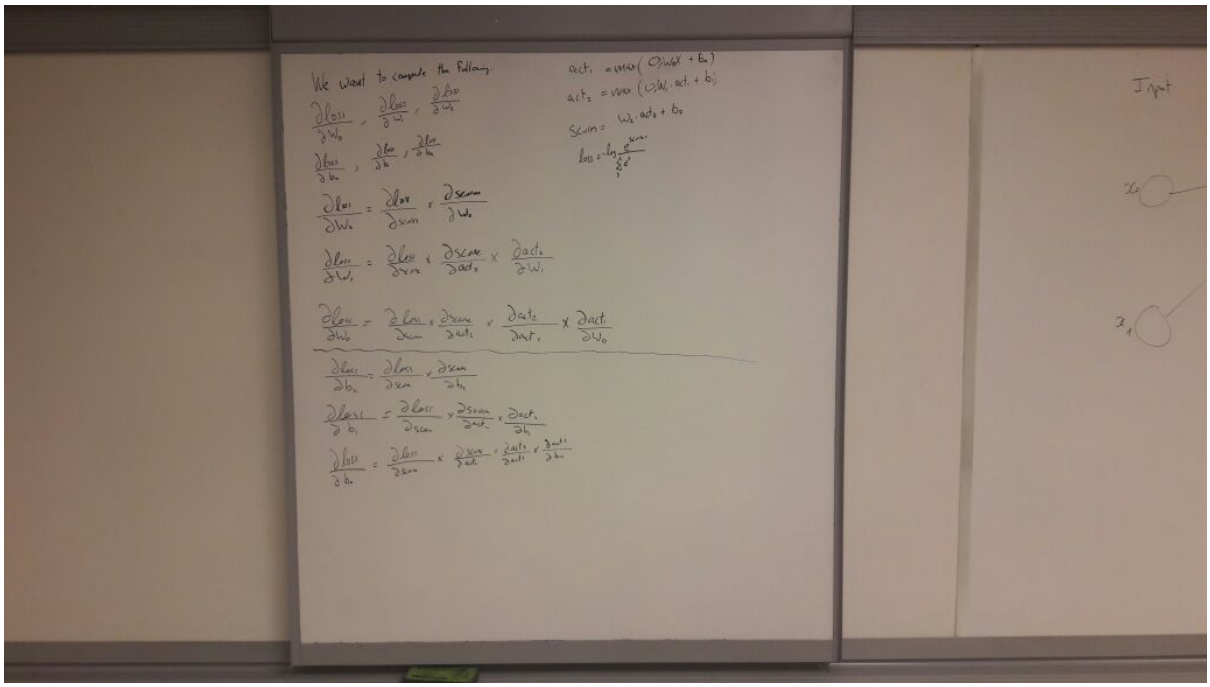
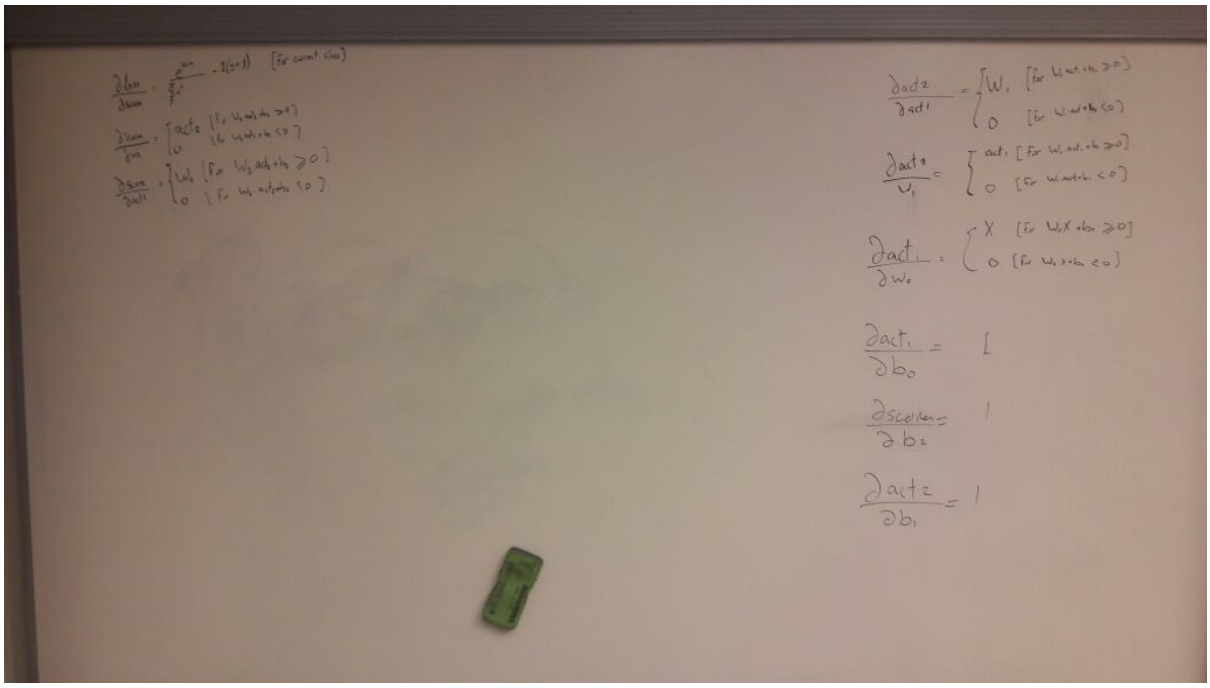
1. 2-layer network architecture and derivation of Error of Backpropagation



Network Architecture



Derivation of Backpropagation 1



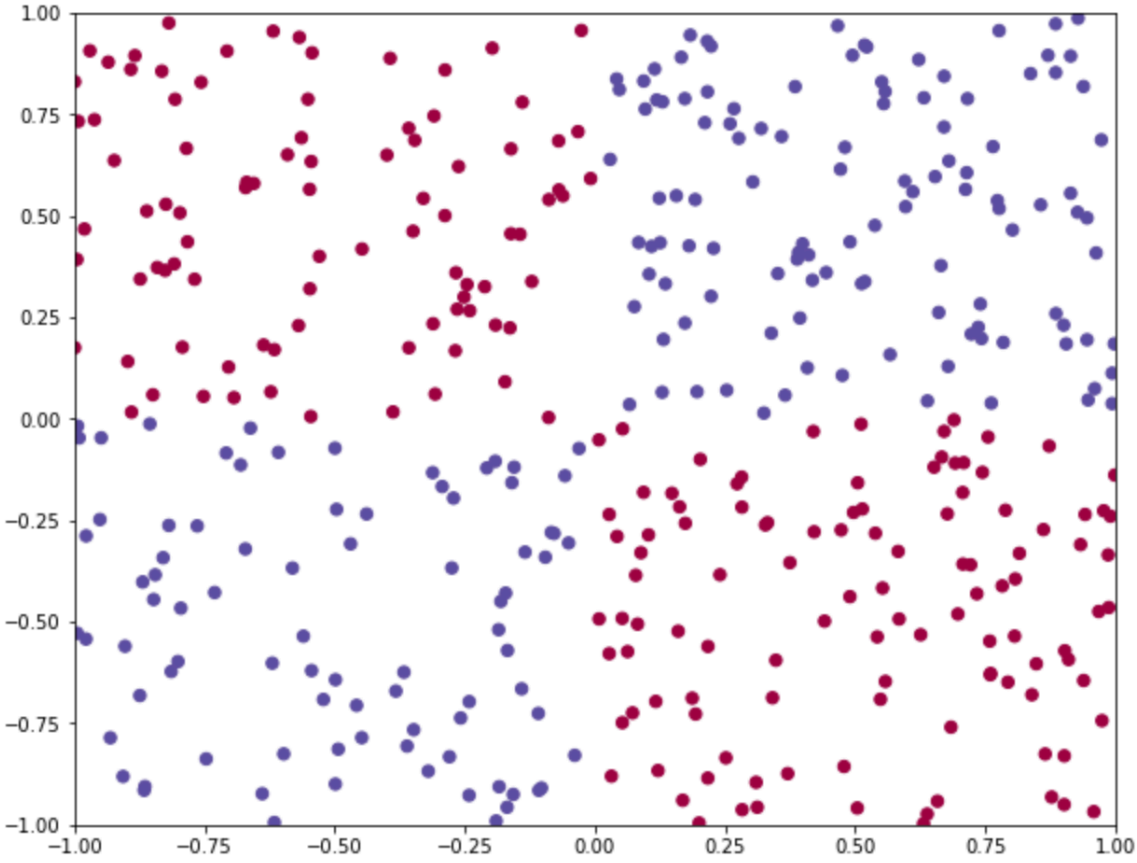
Derivation of Backpropagation 2

2. Network architecture differed depending upon the level of non linearity of the problem. The more non linear it was (face) the more layers and neurons were needed to conquer the problem. {ring, xor, circle, face}

- Important note: I used regulization (L2) as to reduce over fitting (lambda = 1e-7)
- Learning Rate was set fixed at 0.1
- I used Softmax loss as it was a classification problem.

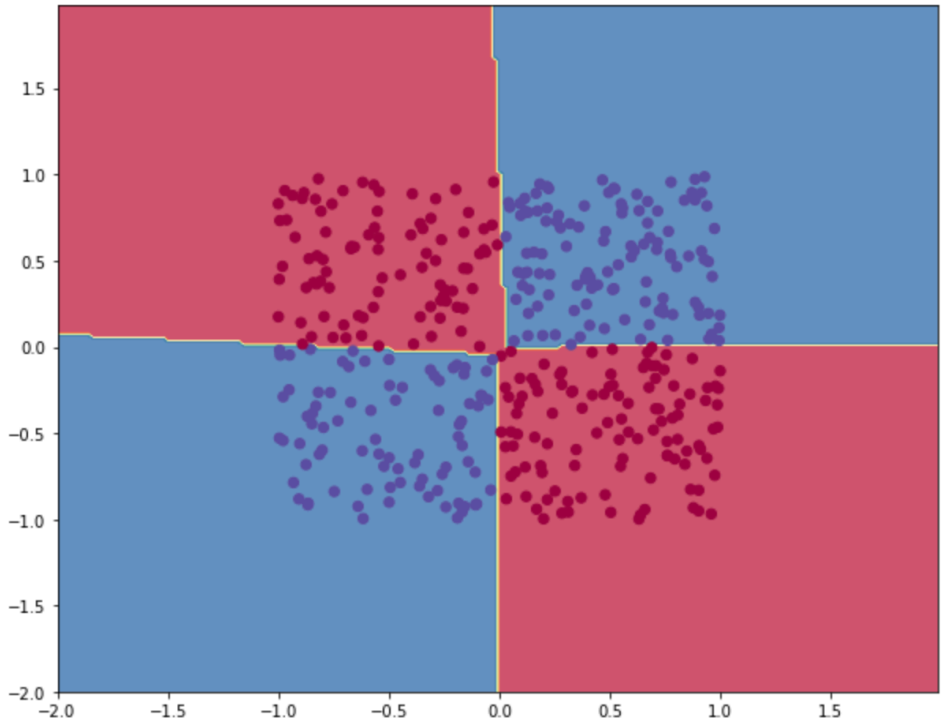
For the XOR problem:

The Architecture had one hidden layer with 20 neurons which was enough to conquer the problem and achieve a 100 % accuracy. Check the figure for data points and for the data boundaries with boundaries added.

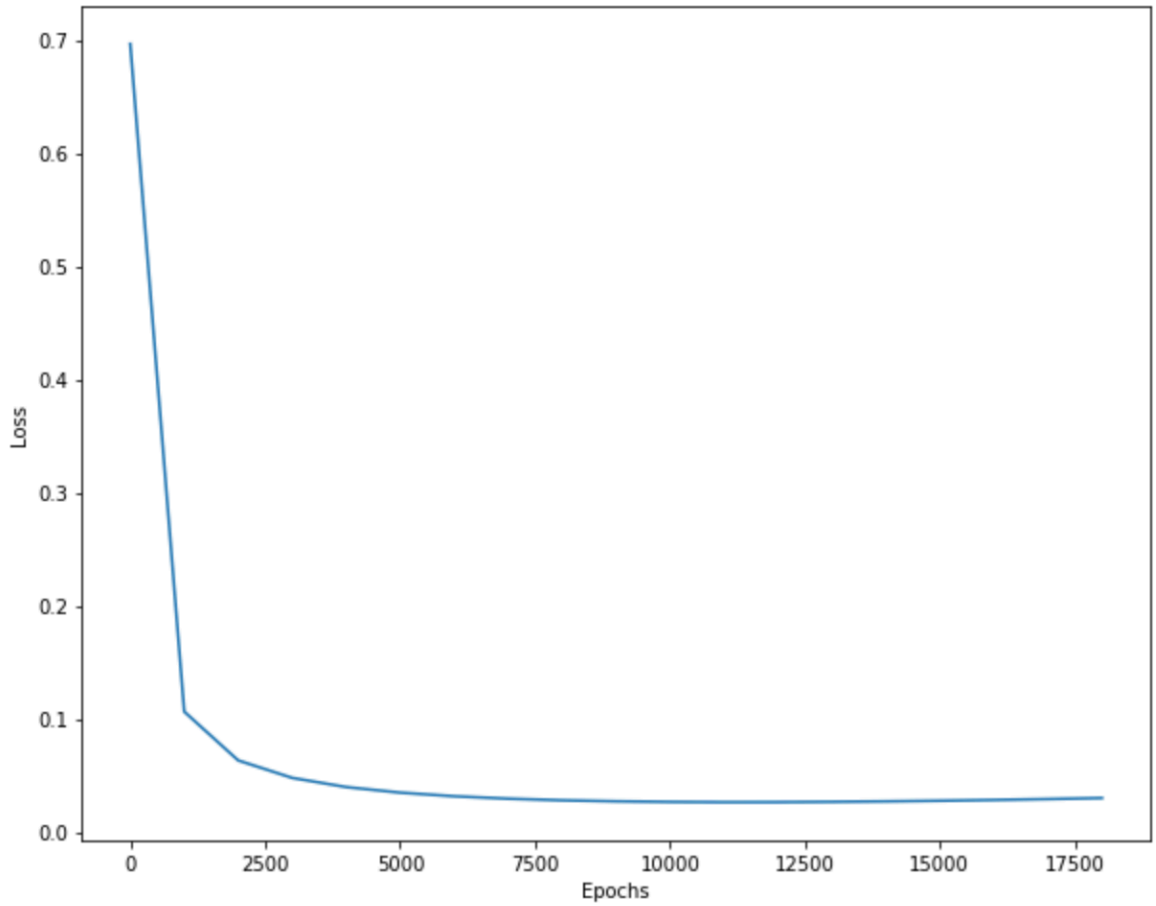


(200, 200)

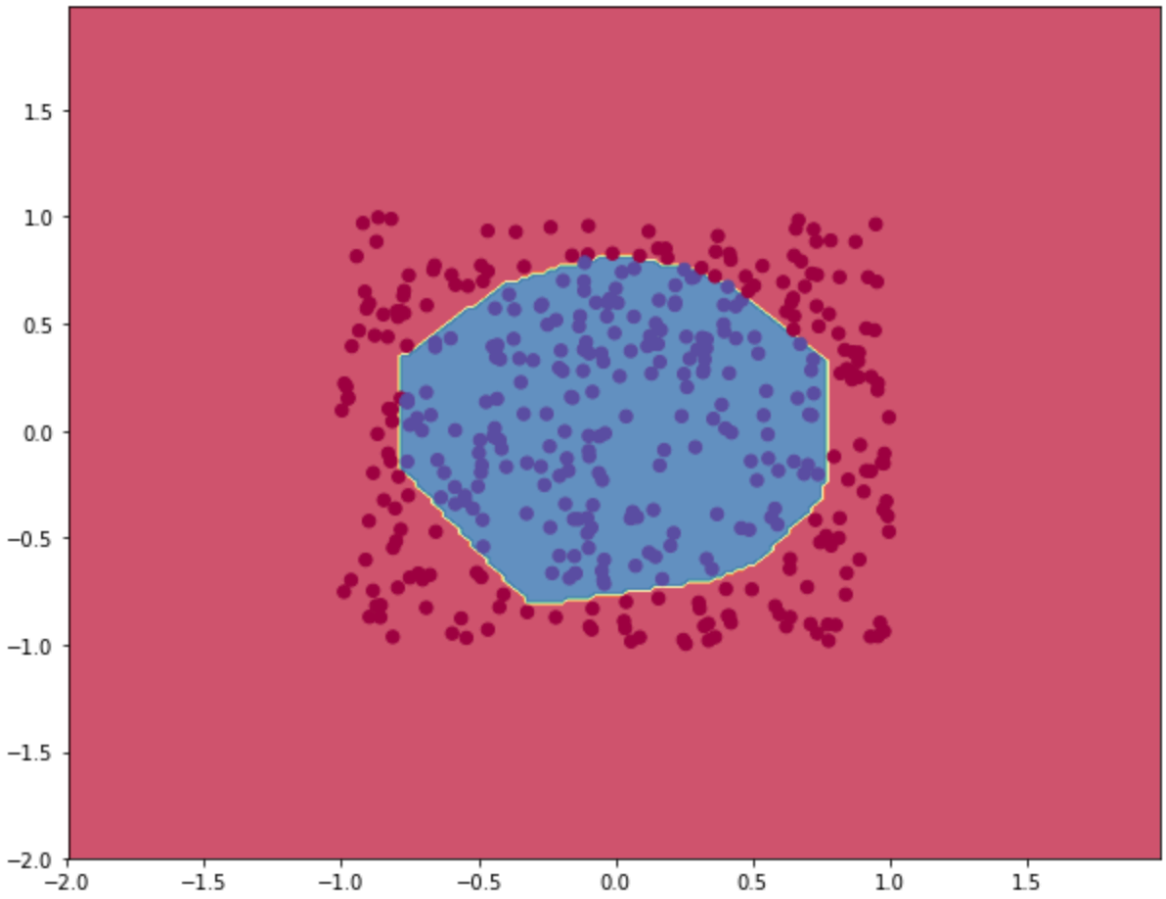
Out[93]: (-1.9969999999999999, 1.9830000000000036)



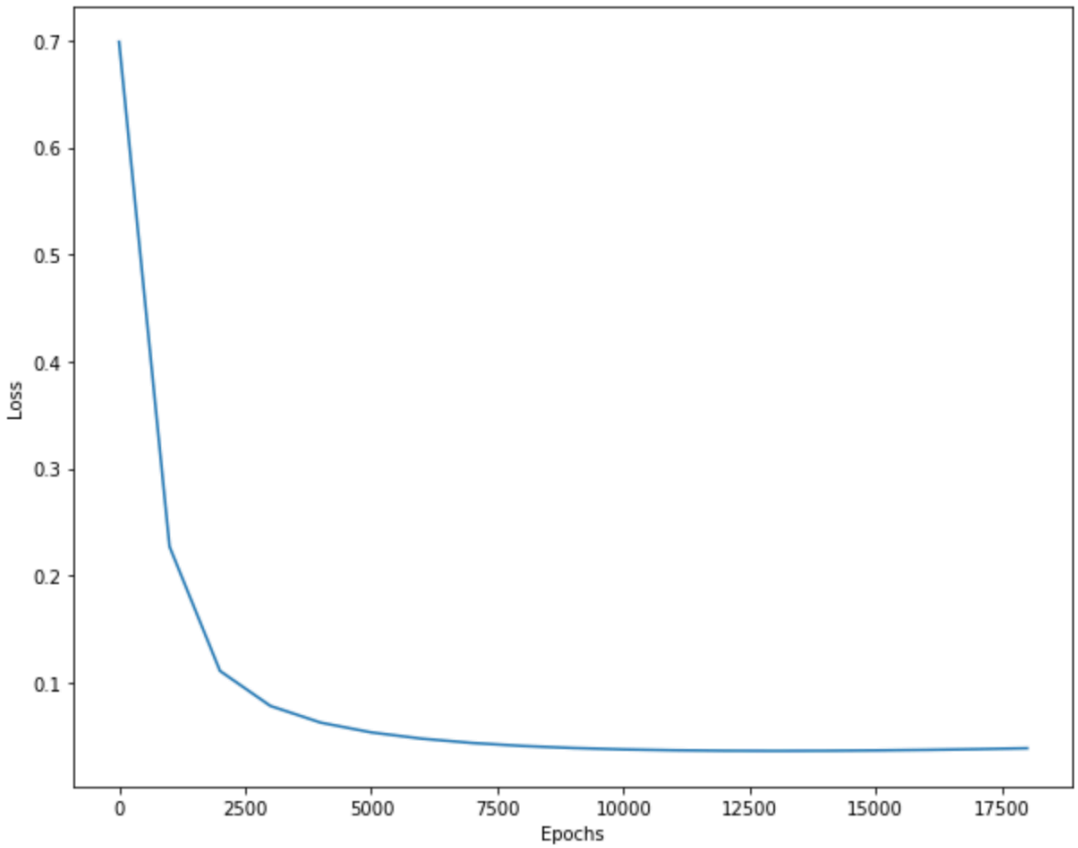
The Loss Vs epochs is shown below:



For the circle problem:
A NN with one hidden layer of 20 layers was sufficient to conquer the data set.

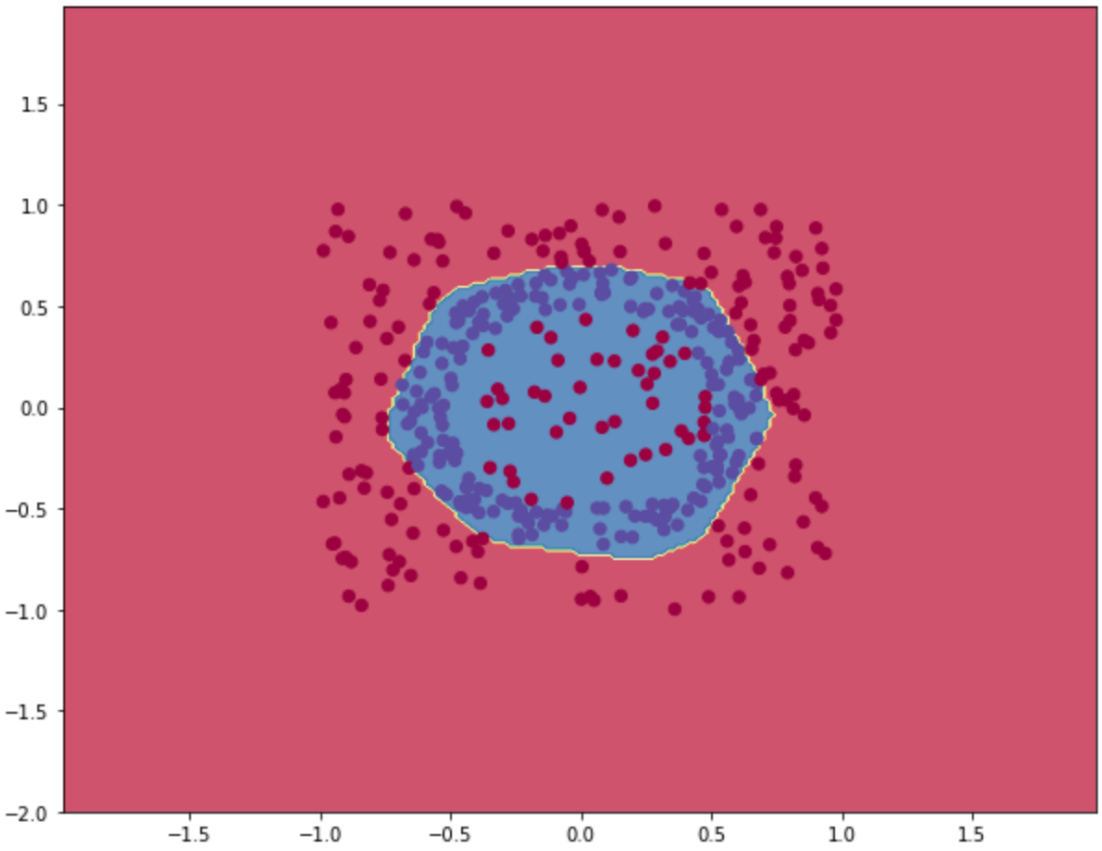


The Loss Vs epochs is shown below:

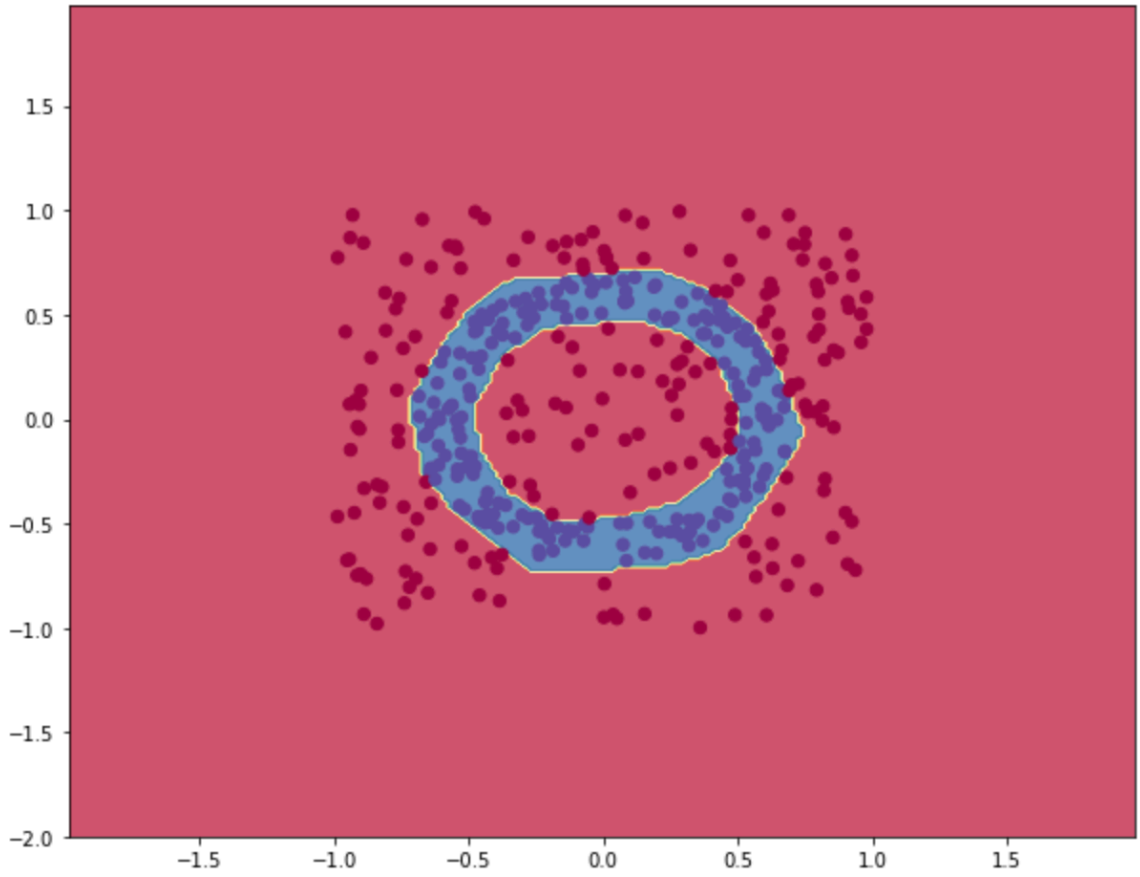


For the ring problem:

A neural Network with one hidden layer of 50 neurons was not sufficient to solve this problem. Thus, I used a neural Network with 2 hidden layers with 20 neurons in each. The following picture shows the outcome of using one hidden layer Vs Two hidden layers.

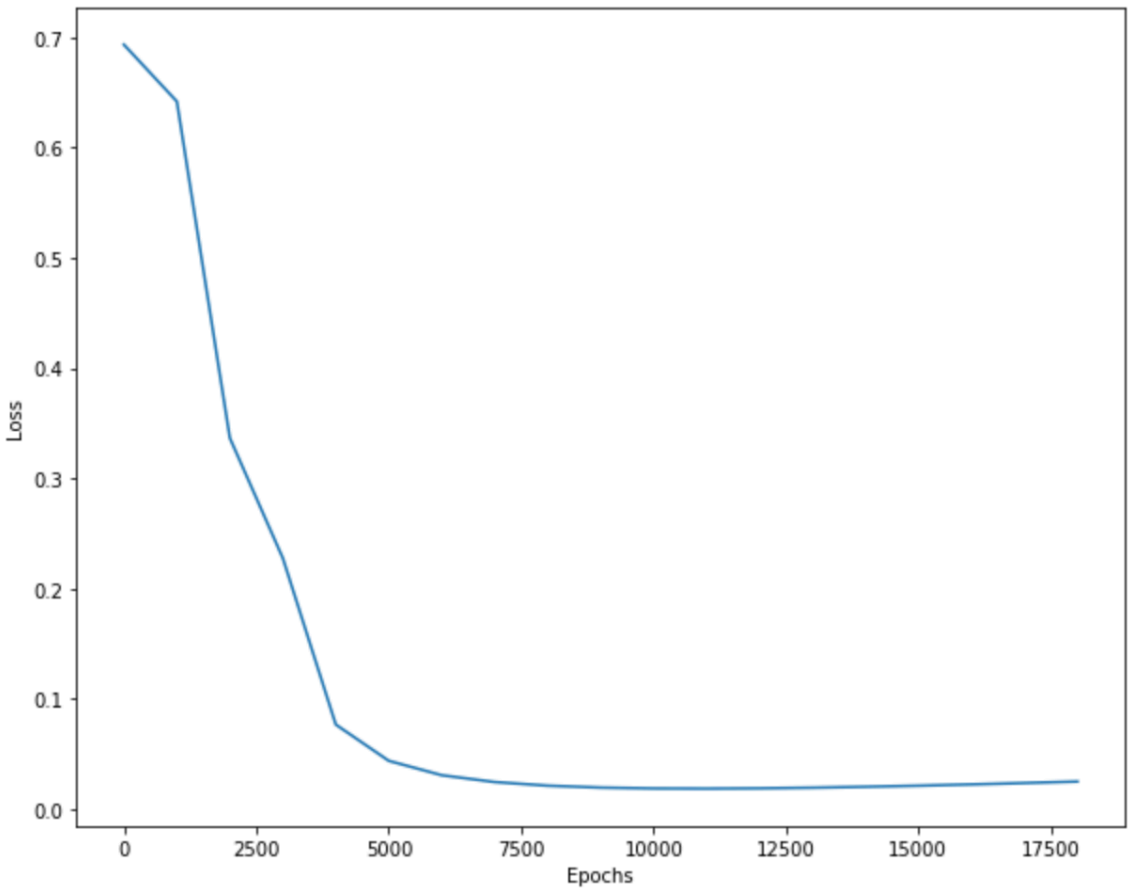


One hidden layer NN

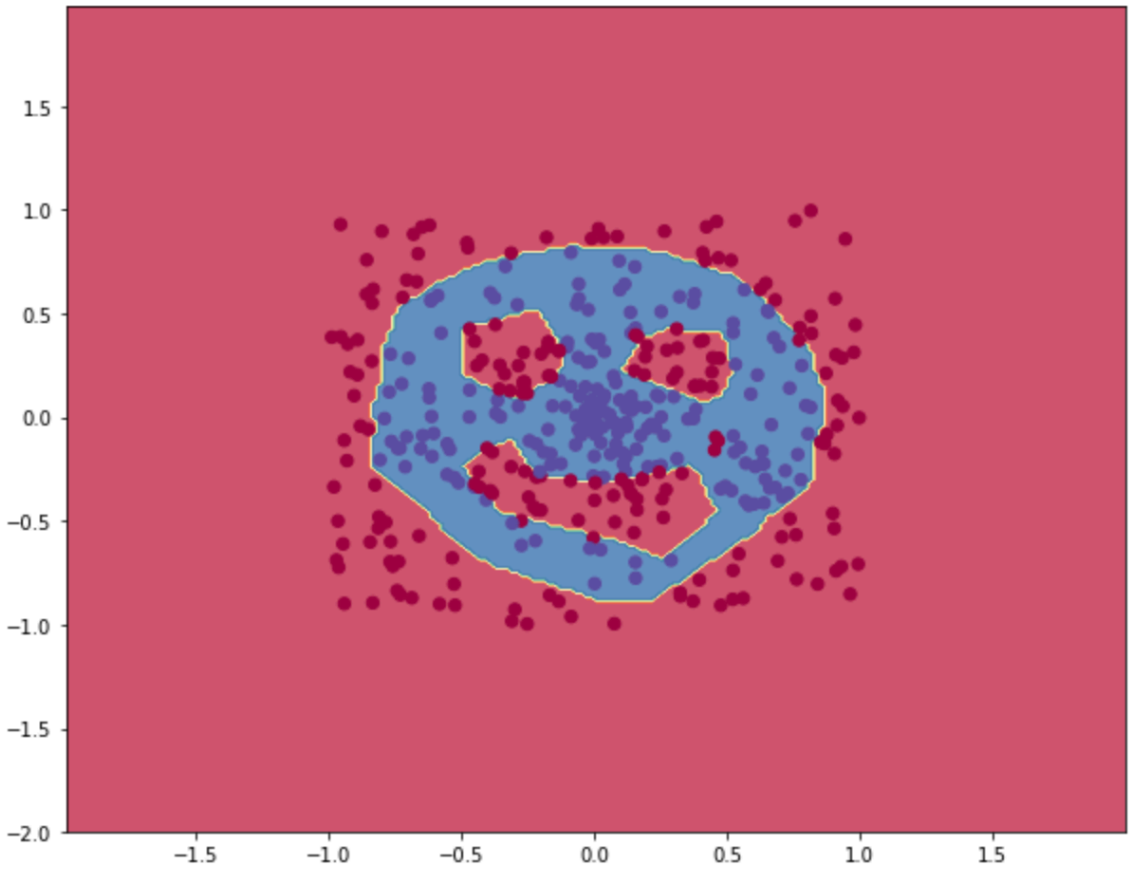


Two hidden layer NN

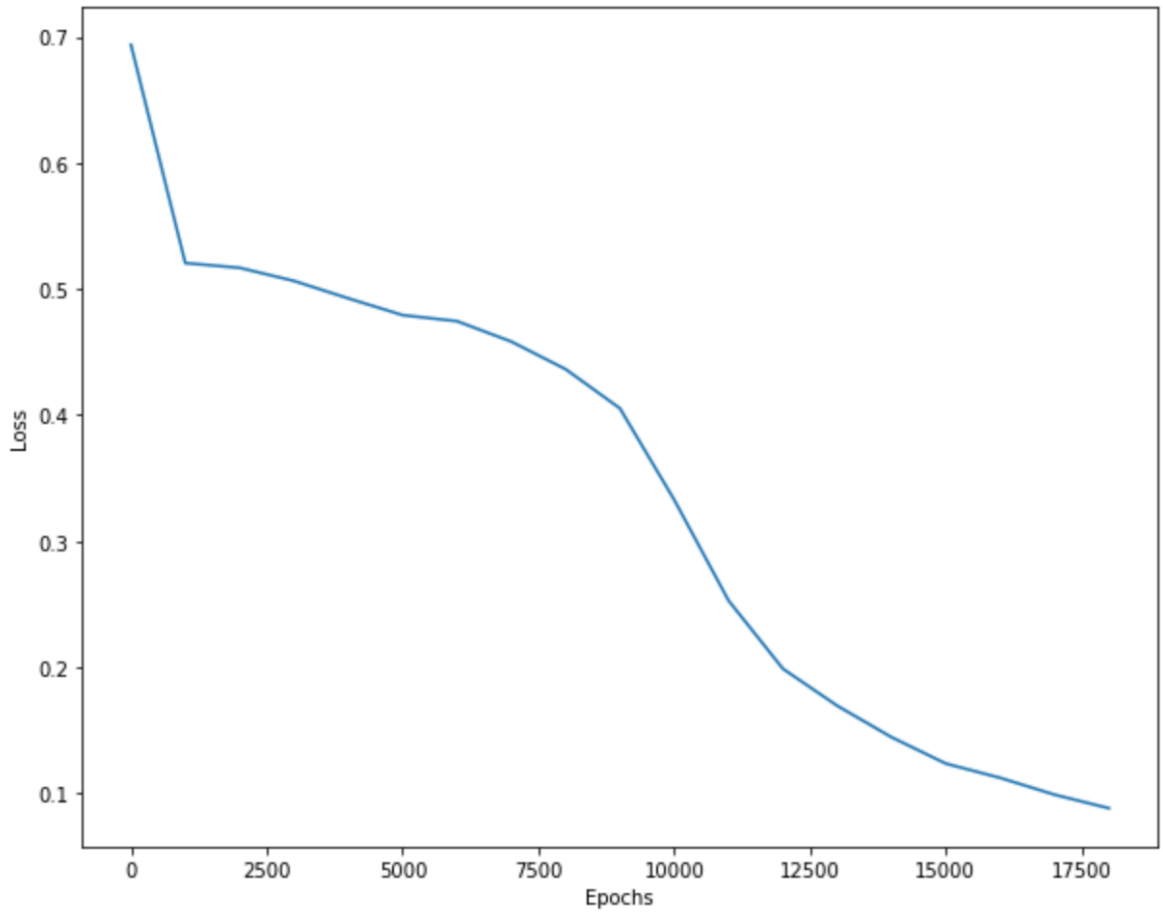
The Loss Vs epochs is shown below:


0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Loss
0
2500
5000
7500
10000
12500
15000
17500
Epochs

For the face problem:
This was the highest non linear problem in the assignment. I was able to achieve 97% accuracy with a 2 hidden layers each containing 25 neurons. The outcome of the NN is shown in the following figure



The Loss Vs epochs is shown below:



I was able to calculate MCCR for the face only, as it was the only problem that the NN was not able to achieve 100% classification accuracy.

MCCR1 = 97%
MCCR2 = 100%