# CSCI964 Computational Intelligence: Assignment #1

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# Task 1

The **two-spiral problem** is a two class problem, which is non-linear.

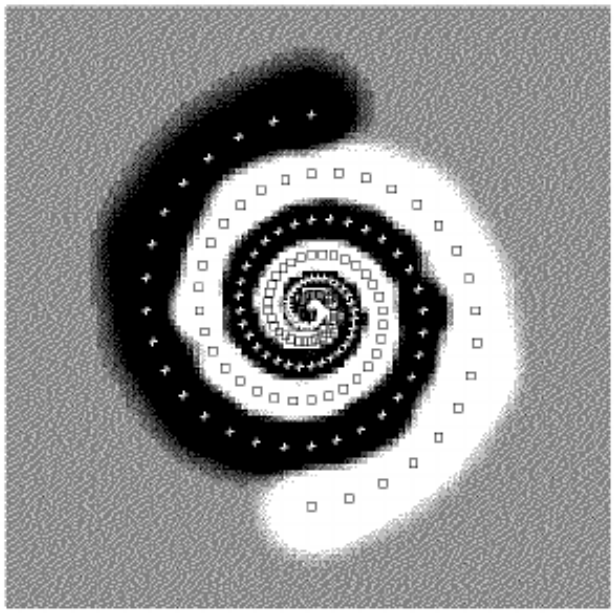


Figure 1: two-spiral problem

I use a 2-layer MLP to solve this problem as the problem is non-linear. First I try to use a single-hidden-layer to fit the problem. But the graph fluctuate heavily. I try to turn down the learning rate(LR) and turn up the momentum (Mtm) so that it can converange more smoothly. But the wrong rate is high.

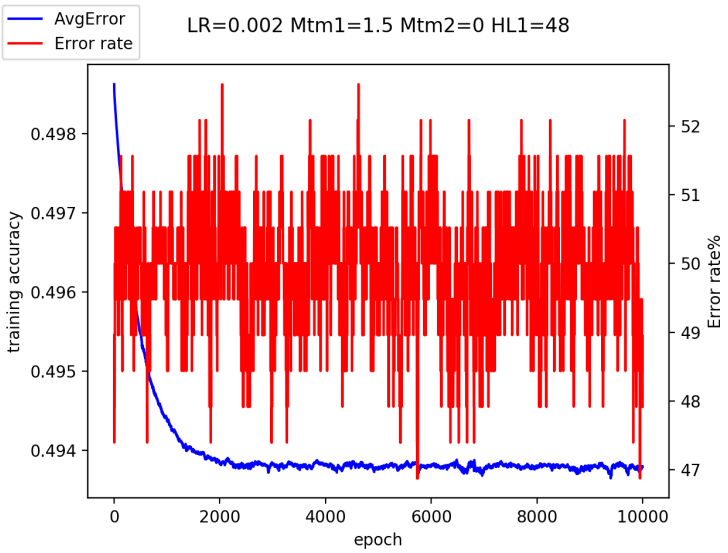



Figure 2: 3-layer MLP

The I add one hidden layer to solve it.

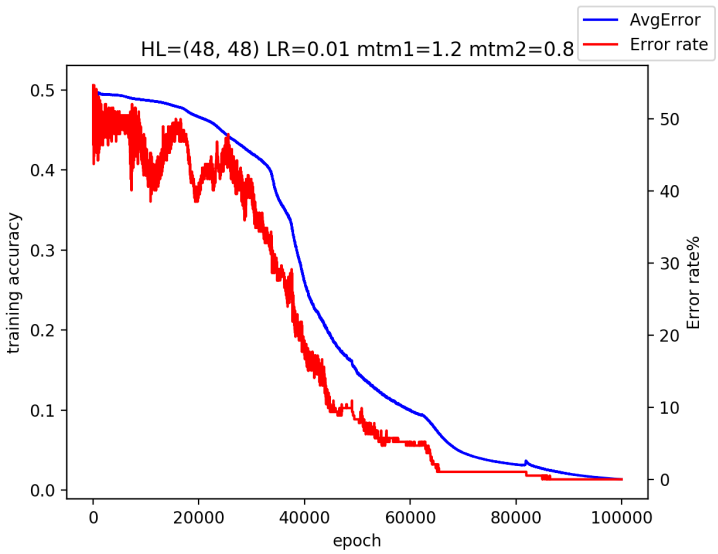



Figure 3: 4-layer MLP

The model applied on test dataset is : AvgError = 0.001843, Error rate = 0.82%. Generally, It's a good model. But the performance is not optimized.
Adding an extra layer into it:

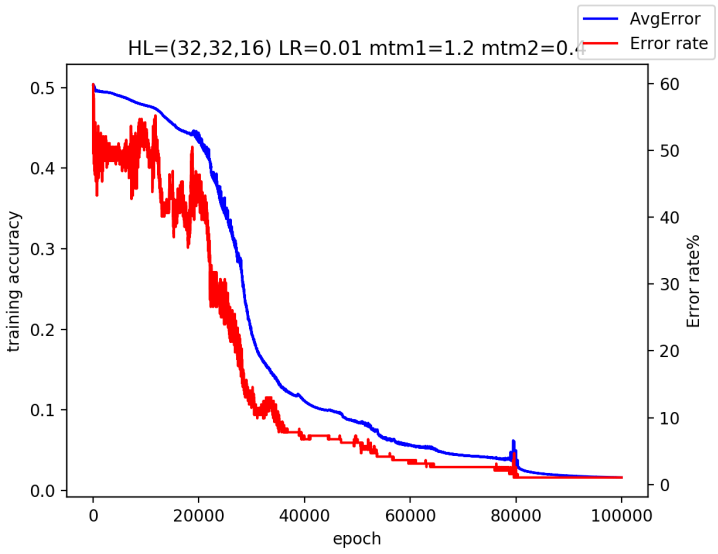
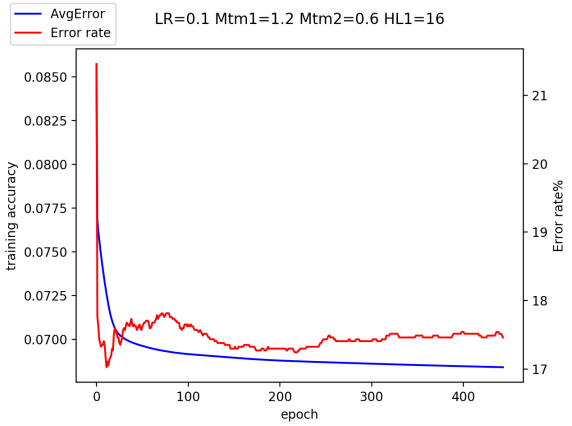



Figure 4: 5-layer MLP

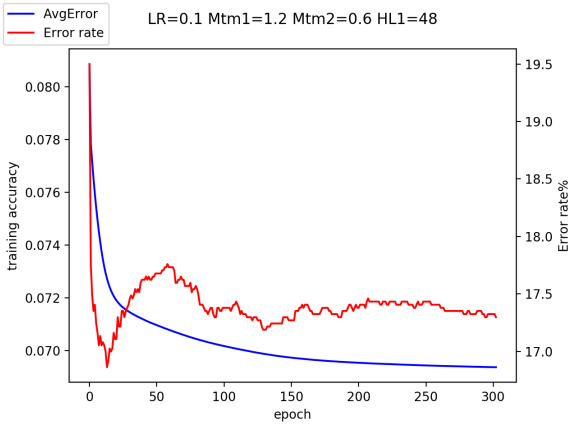
For Test Set $AvgError = 0.0028466$ and $Errorrate = 1.56\%$ though it predict weeker than the second MLP, but it perform better in computation complexisity.

# Task 2

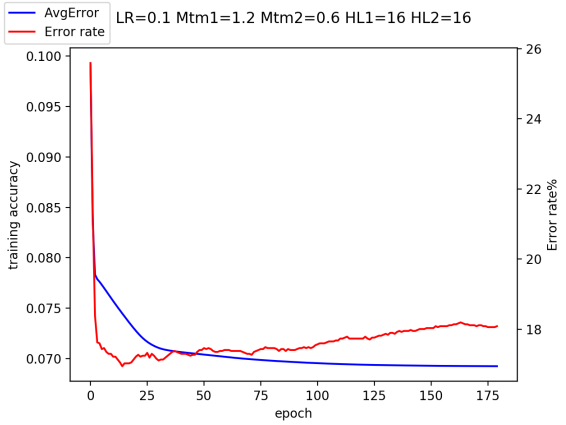
## 1-hidden-layer MLP



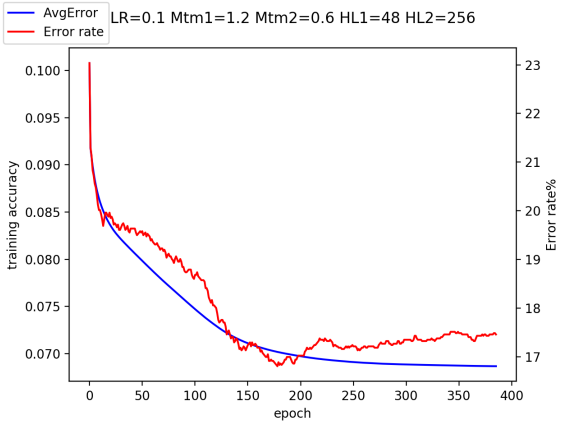

(a) fig1.



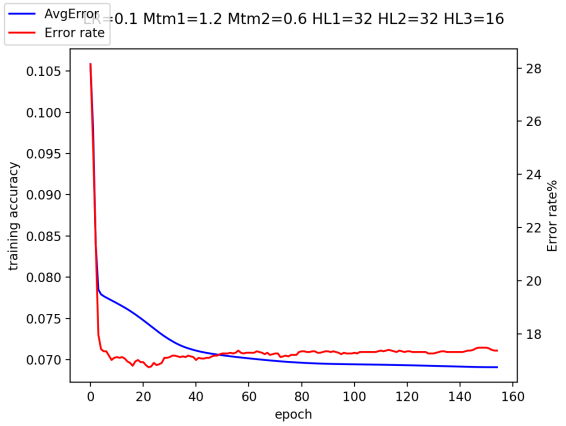

(b) fig2.



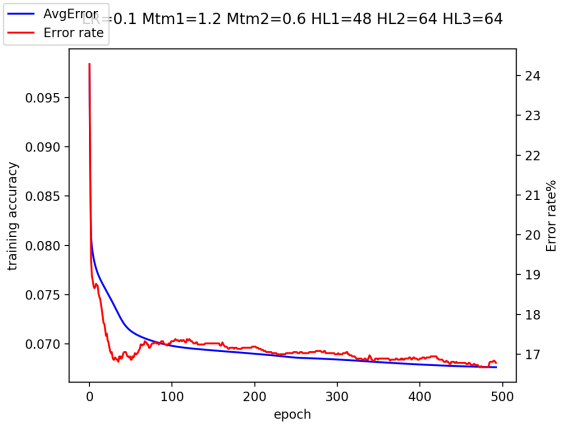

(c) fig3.




(d) fig4.




(e) fig5.




(f) fig6.

Figure 5: MLP

Problem 2 continued on next page...

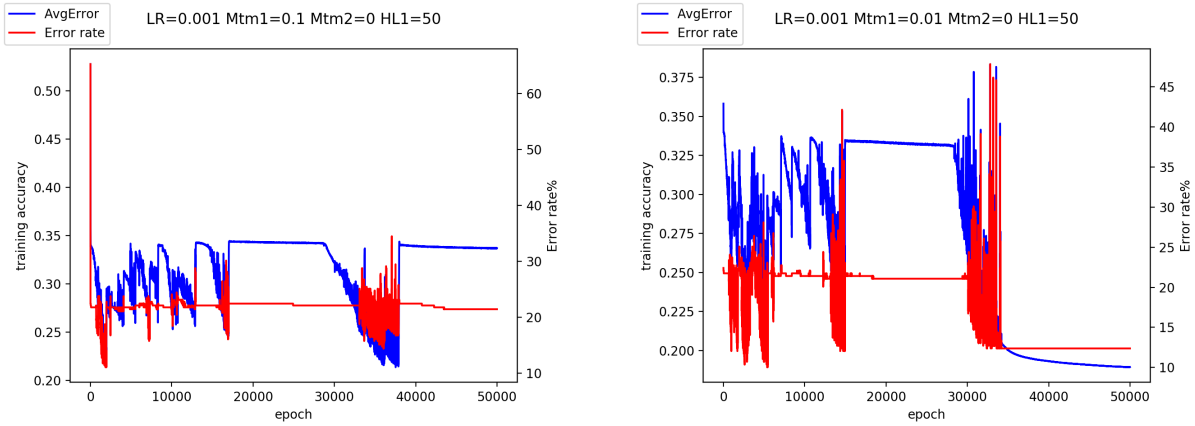
The performance of these MLP is:

| Hidden Layer | Average Error | Error rate | Training Time |
|---|---|---|---|
| 16 | 0.071 | 0.23 | 5s |
| 48 | 0.075 | 0.238 | 16s |
| 16, 16 | 0.07 | 0.224 | 34s |
| 48, 256 | 0.072 | 0.238 | 273s |
| 32, 32, 16 | 0.071 | 0.226 | 158s |
| 48, 64, 64 | 0.070 | 0.224 | 213s |

Table 1: Performance of MLPs

With the consideration of the balance between Accuracy and performance, The 2-hidden-layer (16,16) is the best choice.

# Task 3




(a) fig1. (b) fig2.

Figure 6: bad example

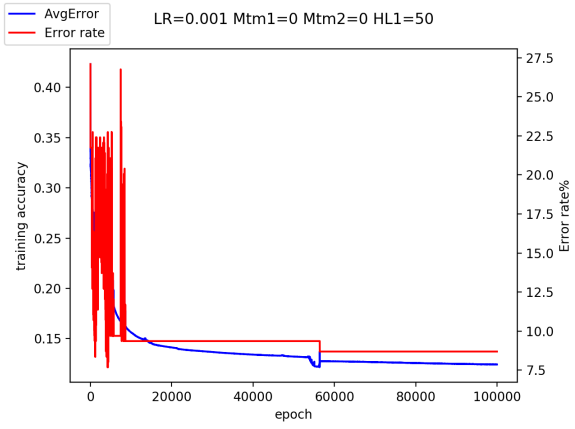



Figure 7: MLP with 1-hidden layer

The final $AverageError = 0.205$ and $ErrorRate = 4\%$, The time to converange the MLP is 100000 epochs.