PRML-Assigmnet-3

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1 Question 1

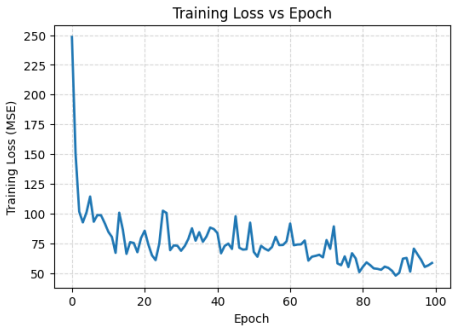
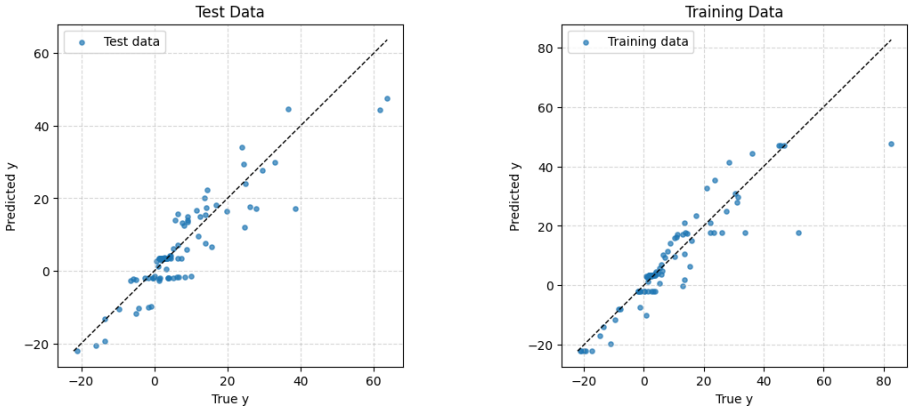


Figure 1: Training Error vs Epochs



(a) Actual vs Predicted (Plot 1)

(b) Actual vs Predicted (Plot 2)

Figure 2: Scatter plot of actual data vs predicted data

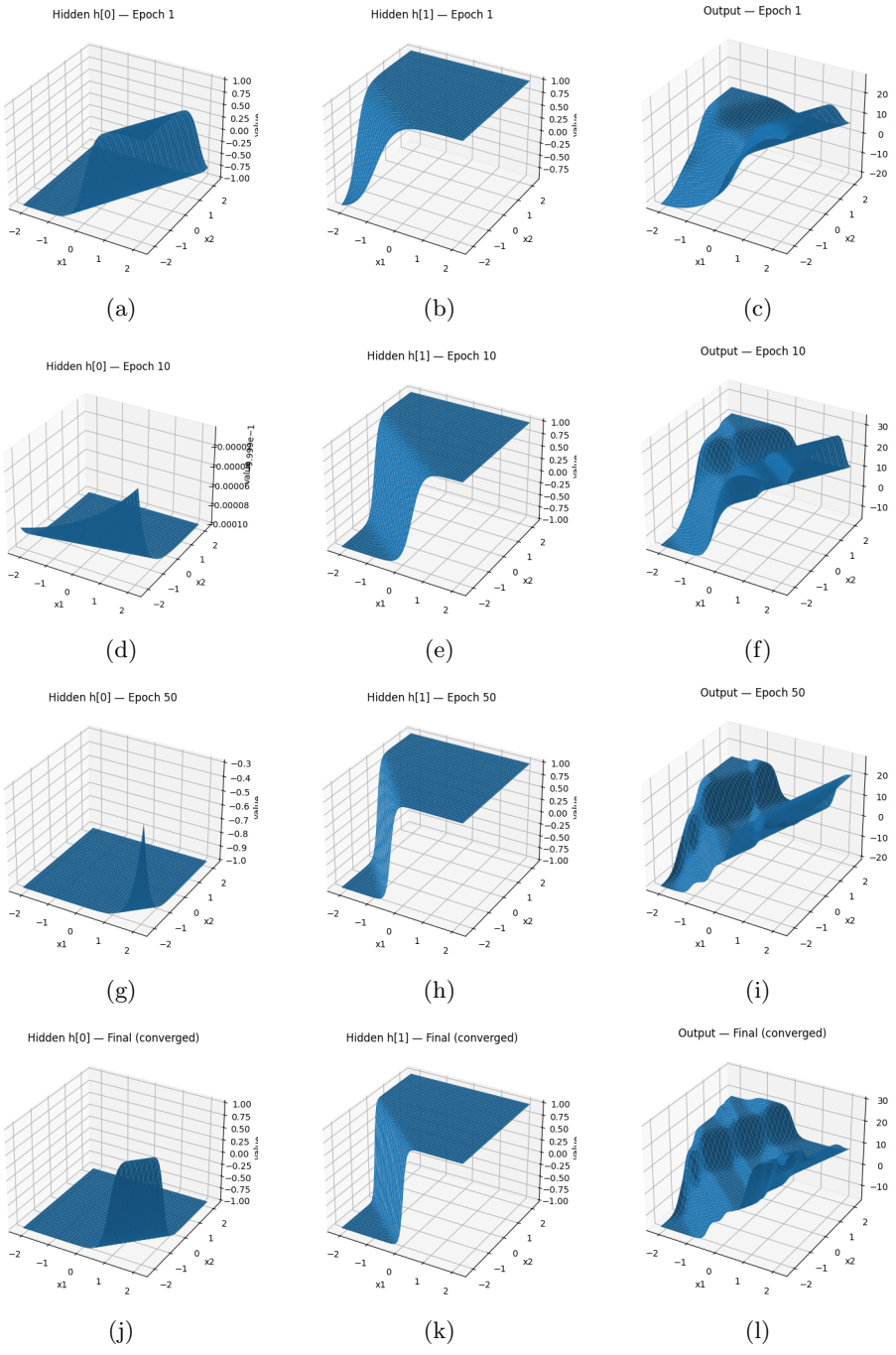


Figure 3: Convergence behavior of the MLFFNN model.

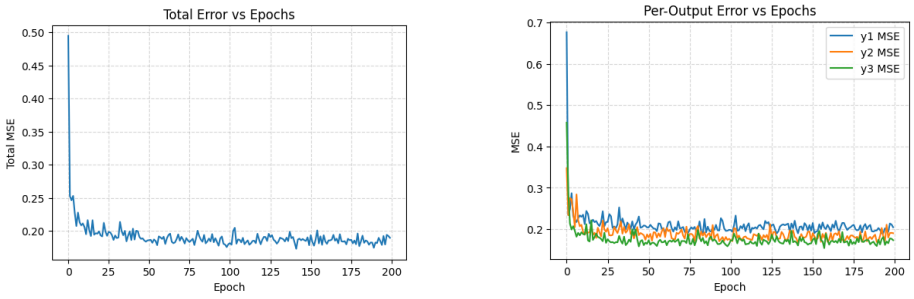
The training RMSE, original scale was 44.153378, and the test RMSE was 31.257387. The given learning rate caused exploding gradients, so a reduced learning rate of **0.07** was used in subsequent experiments.

2 Question 2

The error is as follows after complete training -

Table 1: Training Metrics Summary

Metric	**Value**	
Loss	0.1895	0.2421
MSE_0	0.2044	0.1863
MSE_1	0.1901	0.2957
MSE_2	0.1733	0.2697



(a) Model output visualization (1).

(b) Model output visualization (2).

Figure 4: Comparison of two model output visualizations.

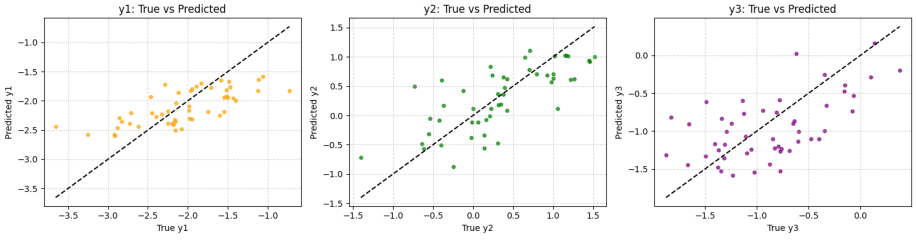


Figure 5: Expanded visualization of model results.

3 Question 3

The training accuracy and loss are reported as **accuracy: 69.19%** and **Loss: 0.6018**. The test loss is 0.6290 and accuracy 70.63%. The required plots illustrating model performance and intermediate results are shown below.

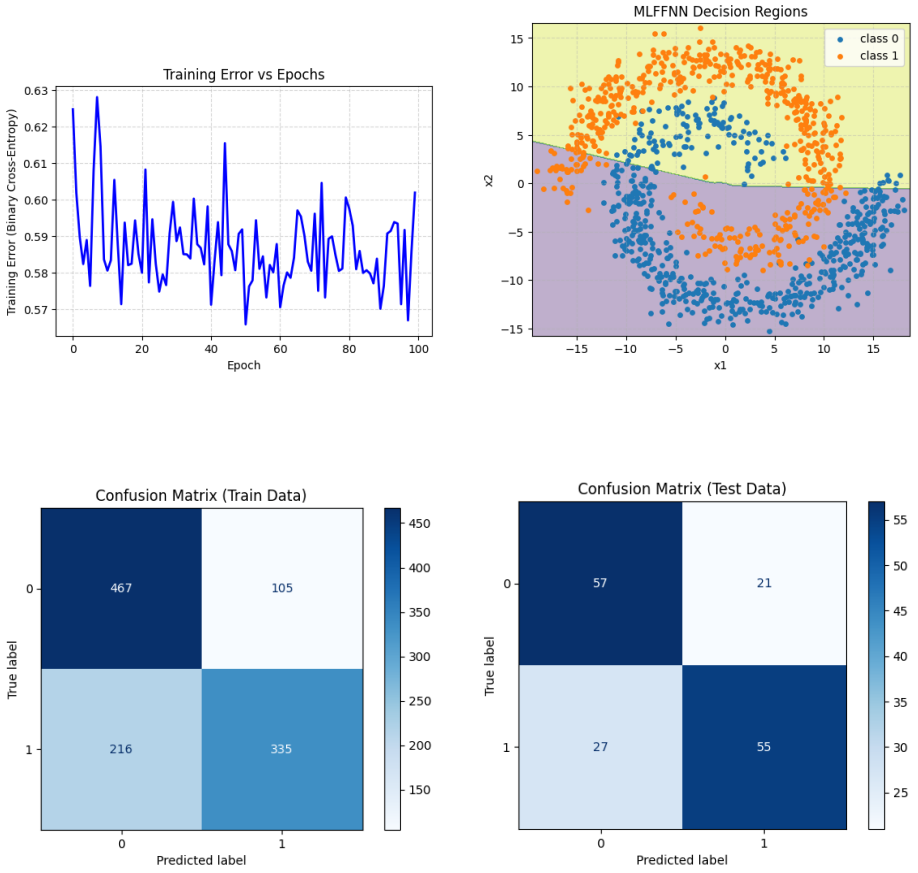
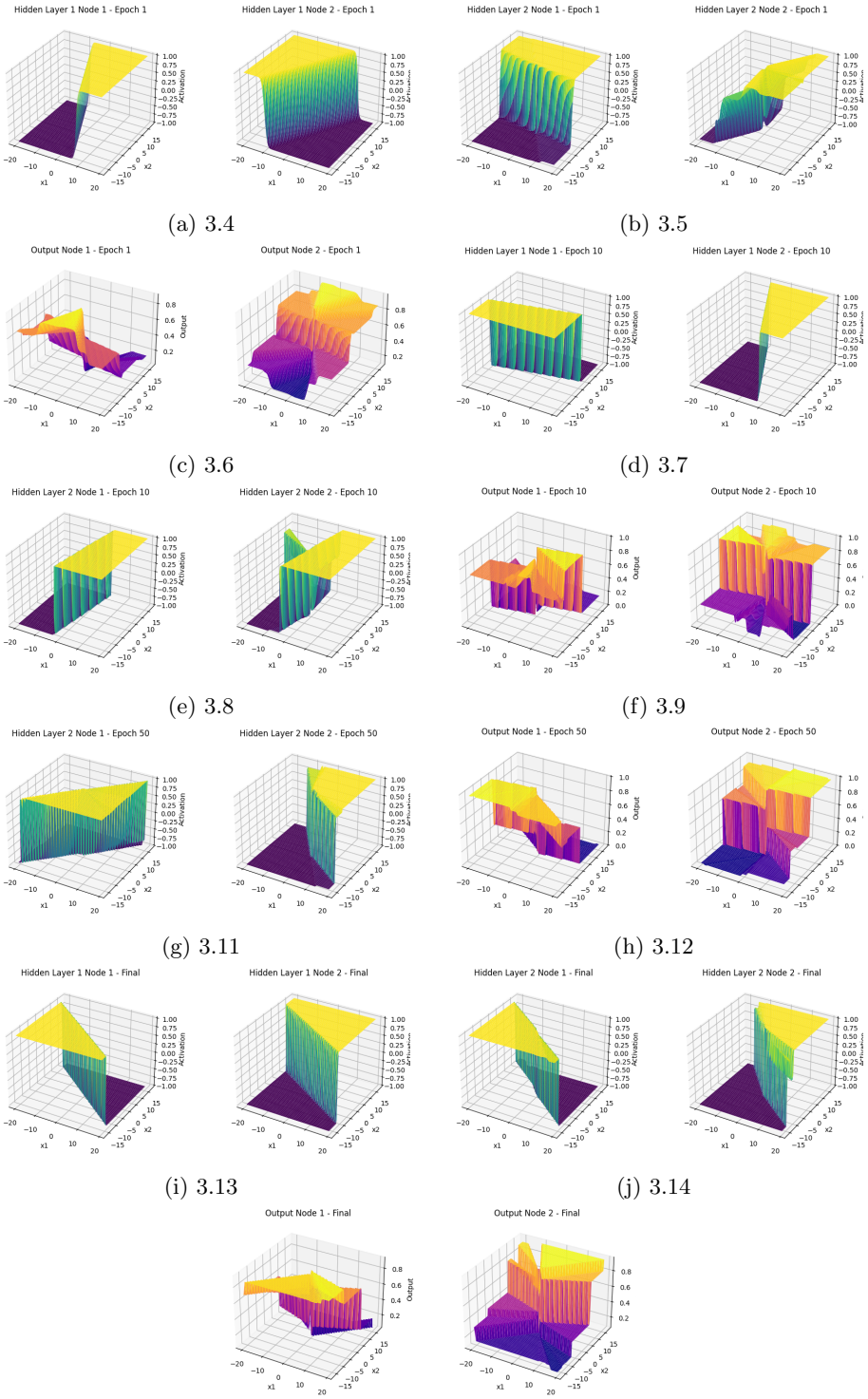


Figure 7: Validation performance and predicted output comparison.



(a) 3.4 (b) 3.5

(c) 3.6 (d) 3.7

(e) 3.8 (f) 3.9

(g) 3.11 (h) 3.12

(i) 3.13 (j) 3.14

(k) 3.15

Figure 8: Visualization of model results. Each subfigure shows a different output visualization or intermediate layer representation.

4 Q.4

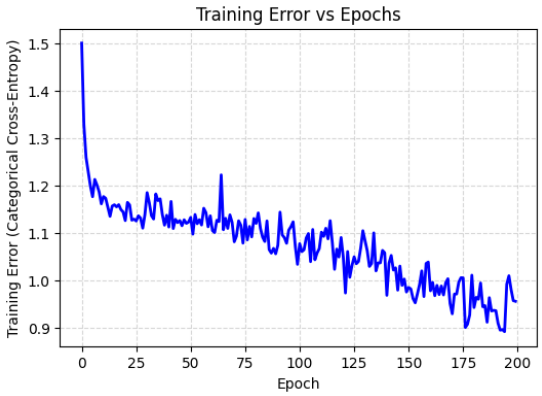
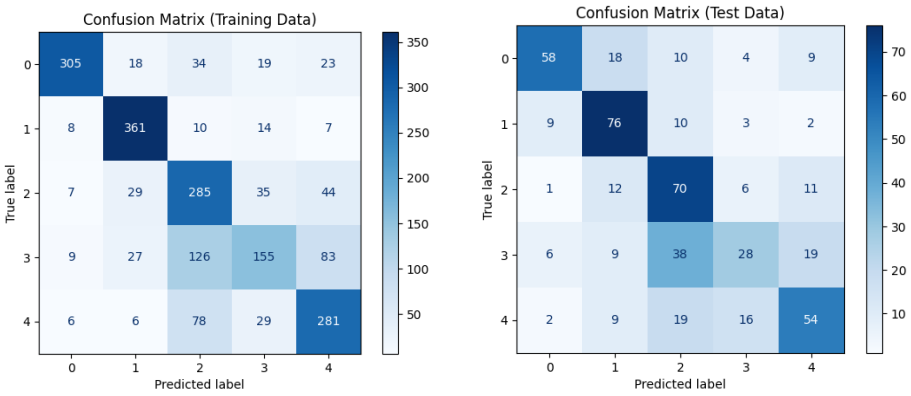


Figure 9: Confusion matrix visualization.

Class	Test Accuracy	Train Accuracy
0	0.5859	0.7644
1	0.7600	0.9025
2	0.7000	0.7125
3	0.2800	0.3875
4	0.5400	0.7025
Average	**0.5732**	**0.6939**

Table 2: Per-class accuracies and average per-class accuracy.



(a) Training error vs epoch.

(b) Confusion matrix.

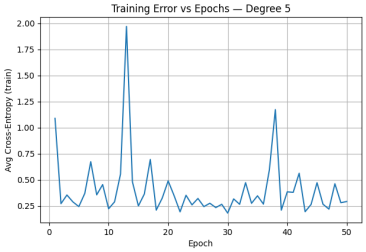
Figure 10: Comparison of model results for Question 4.

5 Q5

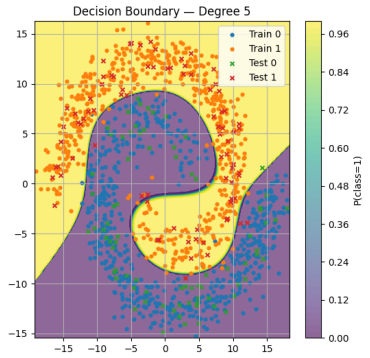
Table 3: Confusion Matrices and Classification Accuracies for Logistic Regression (Polynomial Basis)

Degree	**Dataset**	**TP**	**FP**	**FN**	**TN**
5	Train	532	19	4	568
5	Test	76	6	1	77
7	Train	541	10	5	567
7	Test	78	4	1	77
9	Train	547	4	26	546
9	Test	80	2	7	71

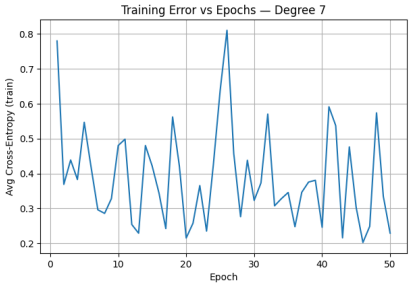
Degree	**Accuracy (%)**
5 (Train)	97.95
5 (Test)	95.62
7 (Train)	98.66
7 (Test)	96.88
9 (Train)	97.33
9 (Test)	94.38



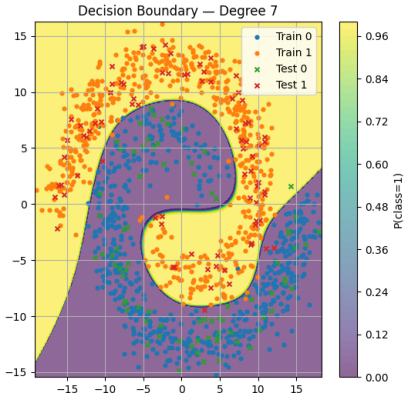
(a) Degree 5 — Train



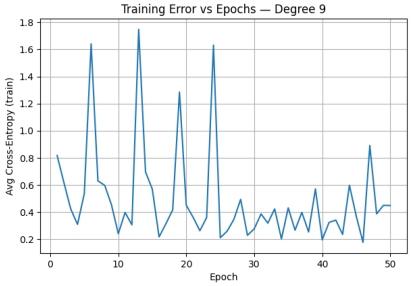
(b) Degree 5 — Test



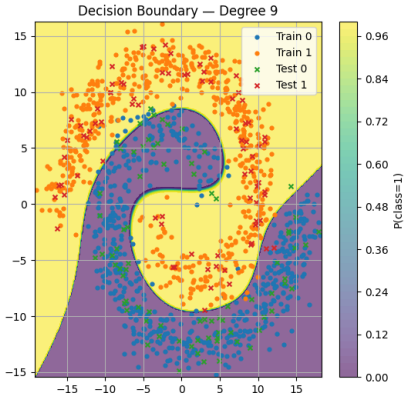
(a) Degree 7 — Train



(b) Degree 7 — Test



(a) Degree 9 — Train



(b) Degree 9 — Test

Figure 13: Errors vs epochs and decision boundary

6 Q.6

Table 4: Classification Accuracy for Different Numbers of Gaussian Basis Functions

No. of Basis Functions (K)	**Chosen σ**	**Train Accuracy (%)**	**Test Accuracy (%)**
50	3.98023	61.05	58.60
75	4.30786	63.20	57.60
100	4.52618	62.65	58.80

Table 5: Confusion Matrices for K = 50

Train

	C1	C2	C3	C4	C5
C1	296	33	15	26	30
C2	29	320	11	15	25
C3	47	30	207	64	52
C4	56	37	57	131	119
C5	32	15	45	41	267

Test

	C1	C2	C3	C4	C5
C1	69	11	5	8	7
C2	6	82	2	4	6
C3	12	12	46	19	11
C4	13	10	17	28	32
C5	6	9	6	11	68

Table 6: Confusion Matrices for K = 75

Train

	C1	C2	C3	C4	C5
C1	305	22	14	29	30
C2	30	313	11	27	19
C3	40	24	203	90	43
C4	53	29	39	183	96
C5	35	12	42	51	260

Test

	C1	C2	C3	C4	C5
C1	68	11	5	10	6
C2	7	78	2	5	8
C3	9	8	48	24	11
C4	16	8	17	29	30
C5	5	7	7	16	65

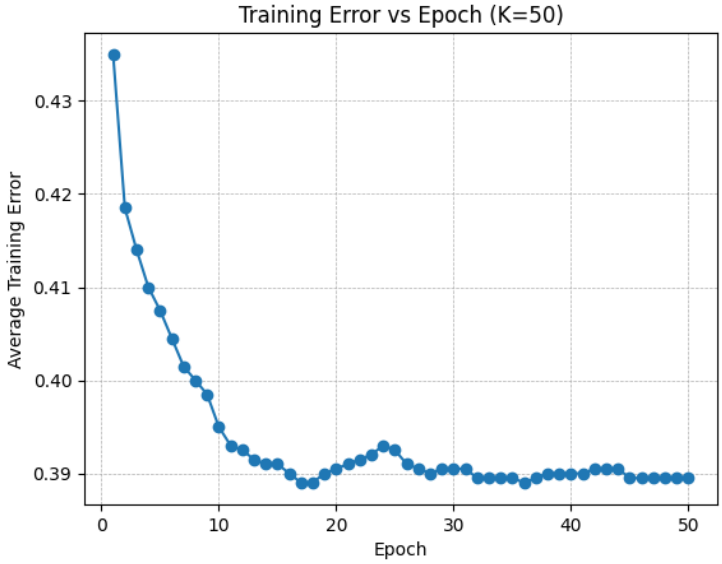
Table 7: Confusion Matrices for K = 100

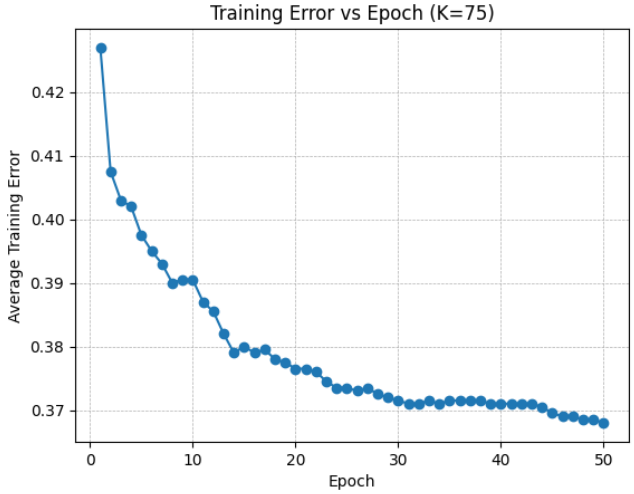
Train

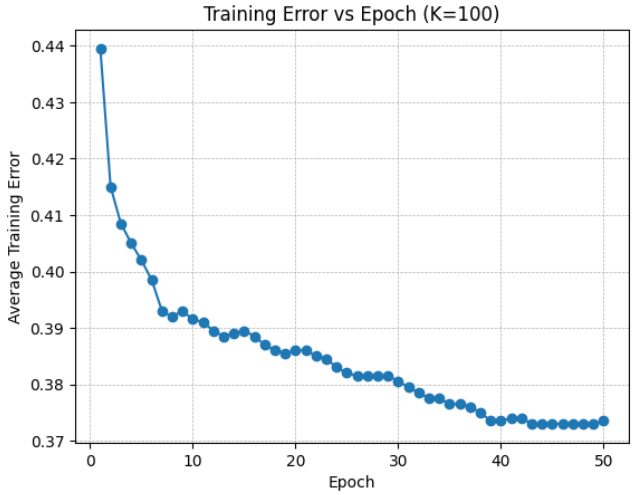
	C1	C2	C3	C4	C5
C1	301	16	12	41	30
C2	27	309	9	31	24
C3	31	19	170	129	51
C4	39	24	28	205	104
C5	24	10	38	60	268

Test

	C1	C2	C3	C4	C5
C1	67	11	4	11	7
C2	6	80	1	6	7
C3	9	6	43	33	9
C4	16	7	11	39	27
C5	4	4	4	23	65






Training Error vs Epoch (K=100)
Average Training Error
Epoch
0.44
0.43
0.42
0.41
0.40
0.39
0.38
0.37
0
10
20
30
40
50