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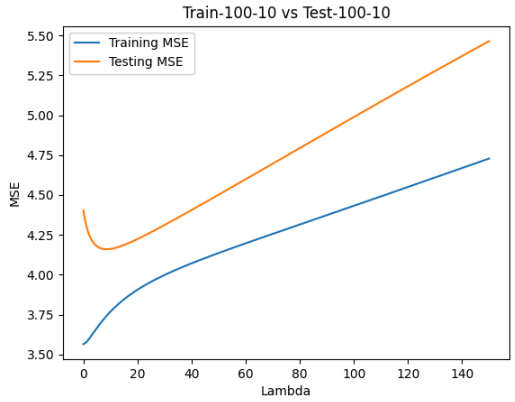
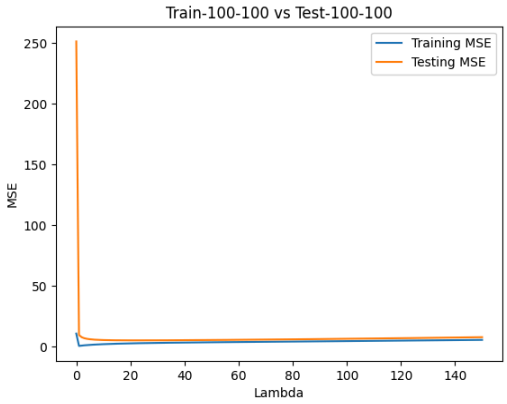
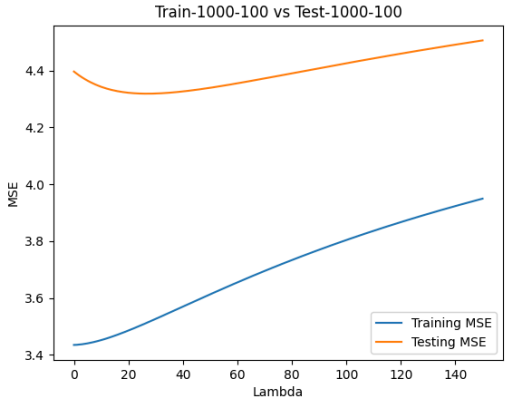
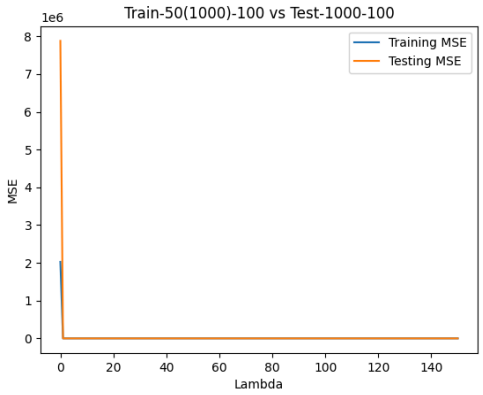
CISC 5790: Data Mining
Assignment 1
Due: 02/20/2024

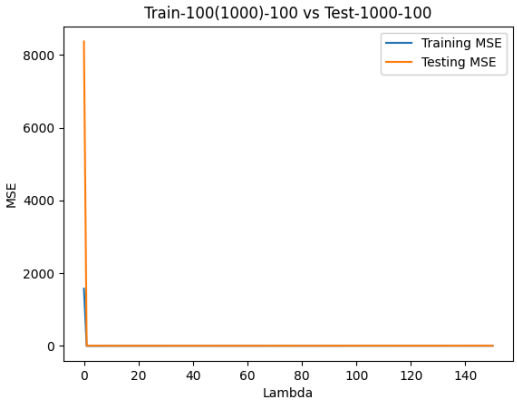
1) Below are the plots for both the train set MSE and test set MSE as a function of lambda for six datasets, with lambda values ranging from 0 to 150.

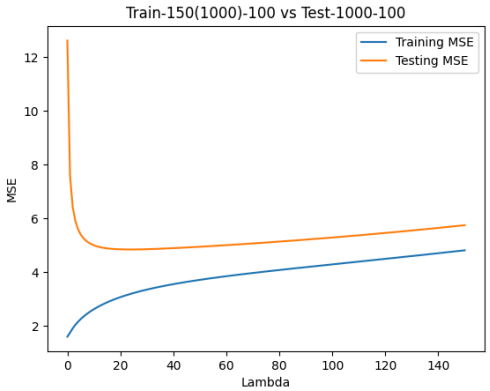








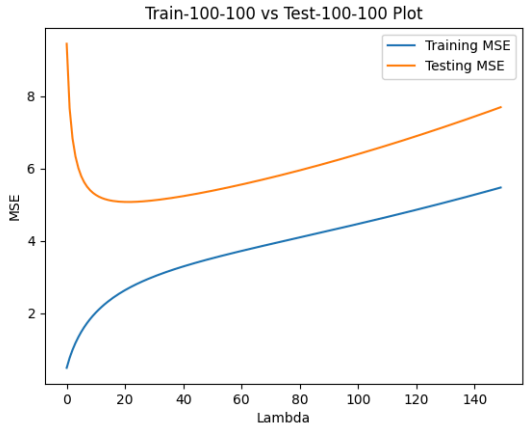


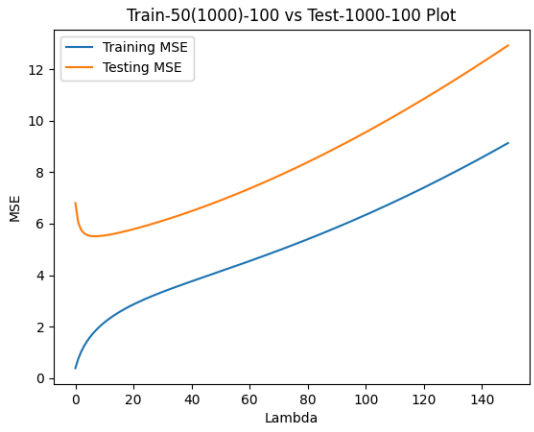


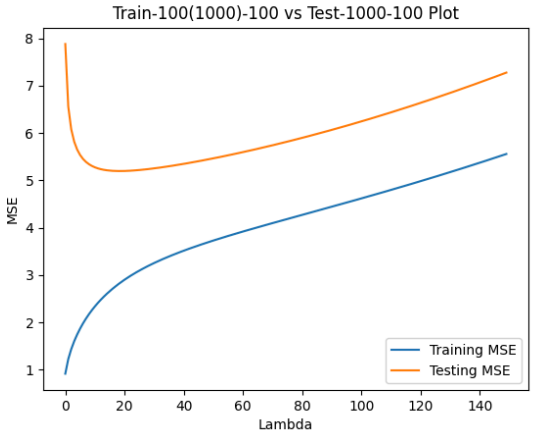
1a) For each dataset, which lambda gives the least test set MSE?

Dataset	MSE (Test set)	Lambda Value
100-10	4.16	9
100-100	5.073	22
1000-100	4.318	27
50(1000)-100	5.512	8
100(1000)-100	5.196	19
150(1000)-100	4.844	24

1b) For each of the datasets, 100-100, 50(1000)-100, 100(1000)-100, provide an additional graph with lambda ranging from 1 to 150







1c) Explain why lambda=0 (i.e. no regularization) gives abnormally large MSE values for the three datasets in (b).

> Setting lambda to zero removes regularization completely. In this case, training focuses exclusively on minimizing loss, which poses the highest possible over fitting risk.

2a) Using the CV technique, what is the best choice of lambda value and the corresponding test MSE for each of the six datasets?

Dataset	MSE (Train set)	Lambda Value
100-10	4.187	13
100-100	4.467	20
1000-100	4.14	39
50(1000)-100	5.285	24
100(1000)-100	4.852	31
150(1000)-100	4.877	47

2b) How do the values for lambda and MSE obtained from CV compare to the choice of lambda and MSE in question 1(a)?

> In part 1(a), the choice of lambdas from each dataset range from 9 to 31. The least test MSE came out to 6.258 for dataset 1 (100-10) when lambda = 9. The lambda values obtained from CV range higher, from 11 to 59. After CV, the least test MSE came out to 5.150 for dataset 2 (100-100) when lambda = 11.

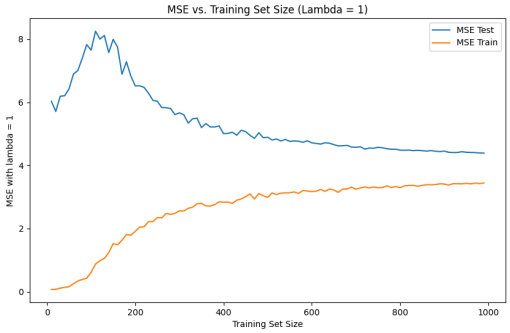
2c) What are the drawbacks of CV?

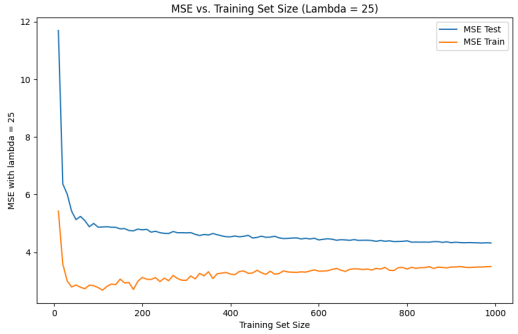
> The disadvantage of using CV is that the training algorithm has to be rerun from scratch k times, which means it takes k times as much computation to make an evaluation. A variant of this method is to randomly divide the data into a test and training set k different times.

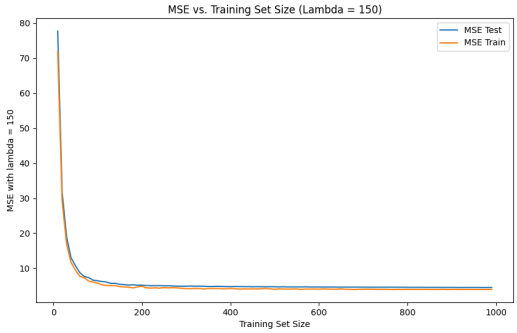
2d) What are the factors affecting the performance of CV?

> The two factors affecting the performance measure of CV are the training and test set. The training set affects the measurement indirectly through the learning algorithm, whereas the composition of the test set has a direct impact on the performance measure. There must not be any overlap between the data used for learning and the data used for validation in the same run.

3) Fix lambda= 1, 25, 150. For each of these values, plot a learning curve for the algorithm using the dataset 1000-100.







As lambda increases, the algorithm performs better and better on the 1000-100 dataset.