Report

Task 4

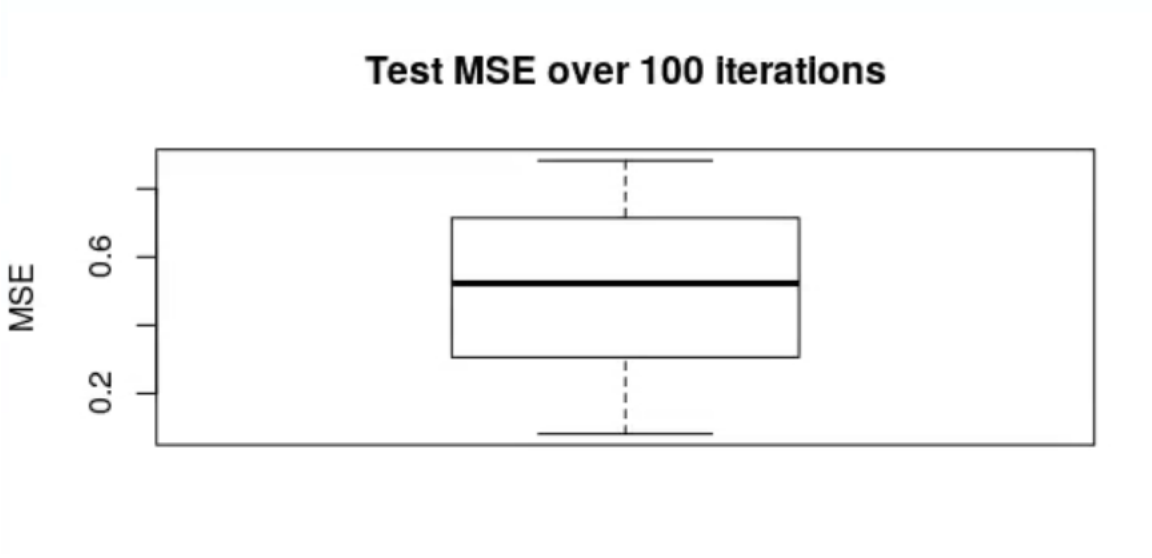
Calculated training and test set MSE for different values of learning rate and number of iterations. Following is the table for the same:

Learning rate, No. of iterations	Training set MSE	Test set MSE
0.1, 100	0.1122	0.1224
0.1, 1000	0.102	0.1377
0.1,10000	0.0969	0.1428
1,100	0.102	0.1478

Task 6

I interpreted this question in two ways, so I solved it with two different approaches. First approach and its result are as follows:

a. Fix value of learning rate = 0.1 and set number of iterations = 100. Define beta randomly between [-0.7,0.7]. Run logistic regression using the random beta values and calculate test MSE value. This process will be run 100 times to generate 100 test MSE scores for randomly generated beta values in the range [-0.7,0.7]. The boxplot for the 100 test MSE values is given below:



b. Run logistic regression for learning rate = 0.1(fixed) and number of iterations = 100(as asked in the question). The values of beta will get updated(optimized) in every iteration and a test MSE will be calculated in every iteration based on the last updated beta values. Following are test MSE values in every iteration:

[1] 0.7193878 0.5918367 0.4948980 0.4234694 0.3979592 0.3571429 0.3316327

[8] 0.3163265 0.3010204 0.2602041 0.2295918 0.2193878 0.2040816 0.1938776

[15] 0.1938776 0.1887755 0.1836735 0.1887755 0.1734694 0.1632653 0.1632653

[22] 0.1632653 0.1632653 0.1632653 0.1581633 0.1428571 0.1428571 0.1428571

[29] 0.1428571 0.1428571 0.1326531 0.1326531 0.1326531 0.1326531 0.1275510

[36] 0.1326531 0.1326531 0.1326531 0.1275510 0.1275510 0.1326531 0.1326531

[43] 0.1275510 0.1275510 0.1275510 0.1275510 0.1275510 0.1275510 0.1224490

[50] 0.1224490 0.1224490 0.1224490 0.1173469 0.1173469 0.1173469 0.1173469

[57] 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469

[64] 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469 0.1122449 0.1173469

[71] 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469

[78] 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469

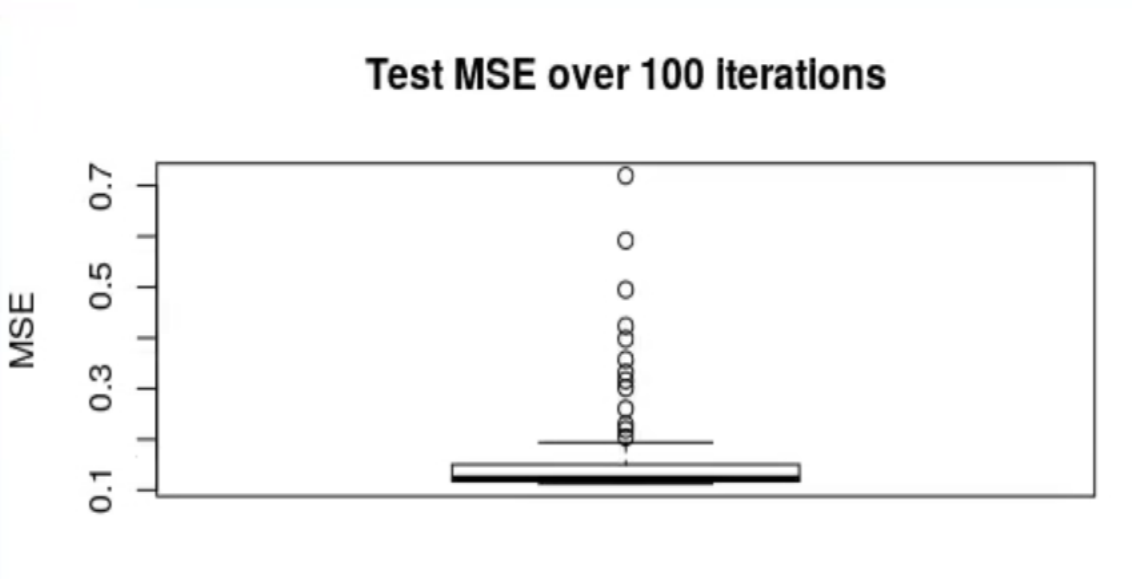
[85] 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469 0.1173469

[92] 0.1173469 0.1173469 0.1173469 0.1122449 0.1122449 0.1122449 0.1122449

[99] 0.1122449 0.1122449

It is evident from the above set of values that the MSE value is very high i.e. 0.719 in the first iteration and goes down to 0.112 in the 100^{th} iteration meaning the model performance has improved.

Boxplot for the above test MSE values is shown below:



Task 5 (Optional question)

Value of learning rate is set to 0.1 and number of iterations is set as 100000. This is done so that there is no chance for the code to stop simulating results before the change in MSE is less than 1%.

Added a nested if block at the end of prediction for loop to check for the following two conditions:

a. Whether the value of j(iteration number) exceeds 10 or not. If this is not done, the exercise cannot be completed because here we are required to compare current MSE with the MSE of 10 iterations back. Unless, there are at least 10 iterations, we cannot go ahead with this.
b. Whether the change between the two MSE values is less than 1% or not. If it is less than 1%, it will execute the if block and store the iteration number in the variable finalIter and will end the loop. If not, it will not enter the if block and will move to the next iteration in the loop.

The last two print statements do the following:

a. Print the iteration number at which the code stopped executing i.e. j.
b. Print the iteration number at which the change in MSE was observed to be less than 1% i.e. j-10.