Negar Mirgati
mirgati@ualberta.ca
1722860

Problem 1)

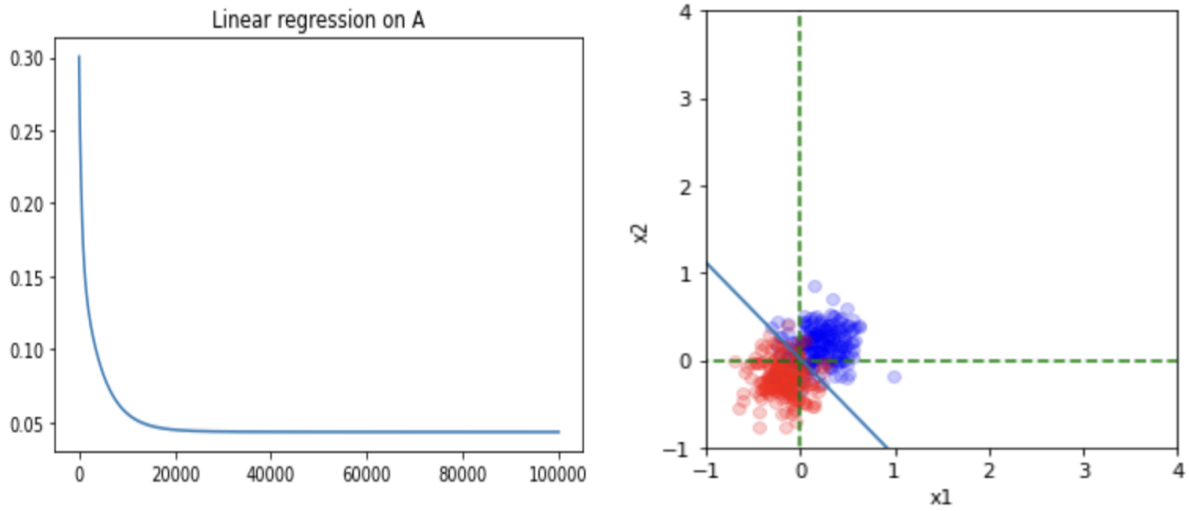

Figure 1: training loss and decision boundary of linear regression on dataset A

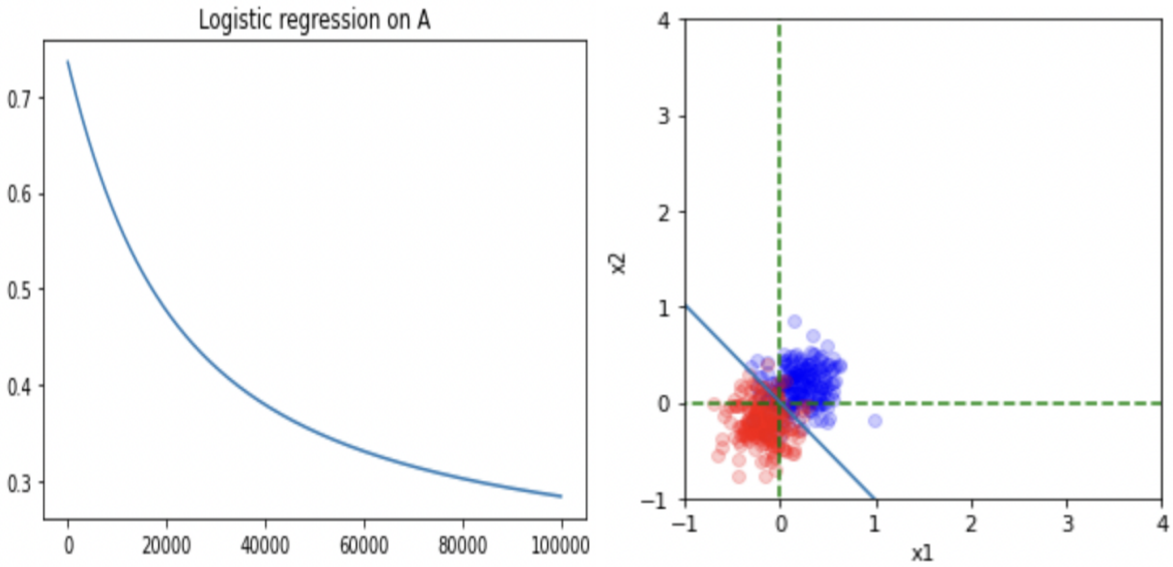

Figure 2: training loss and decision boundary of logistic regression on dataset B

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mirgati@ualberta.ca
1722860

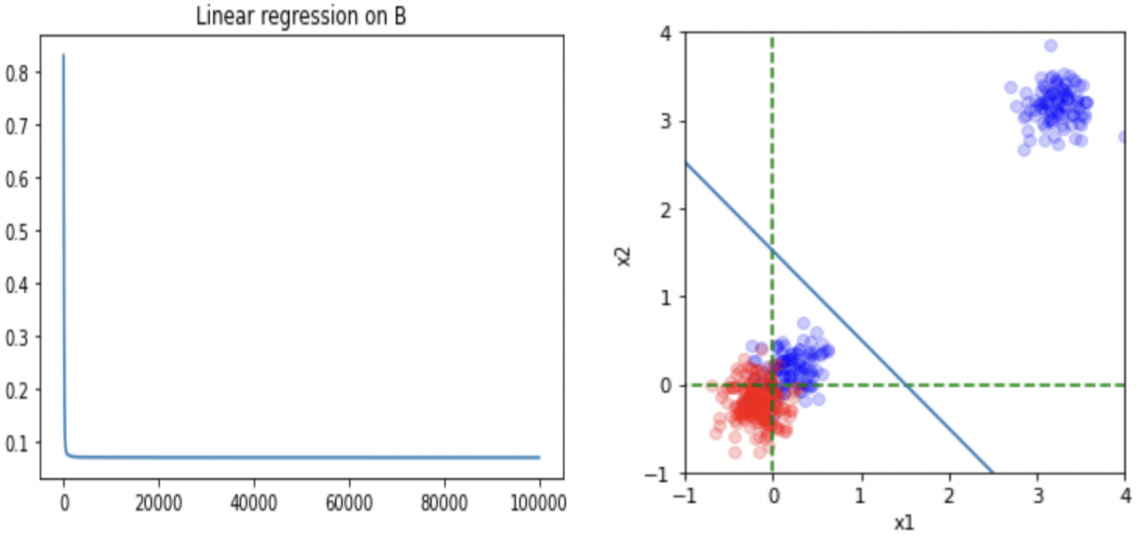

Figure 3: training loss and decision boundary of linear regression on dataset B

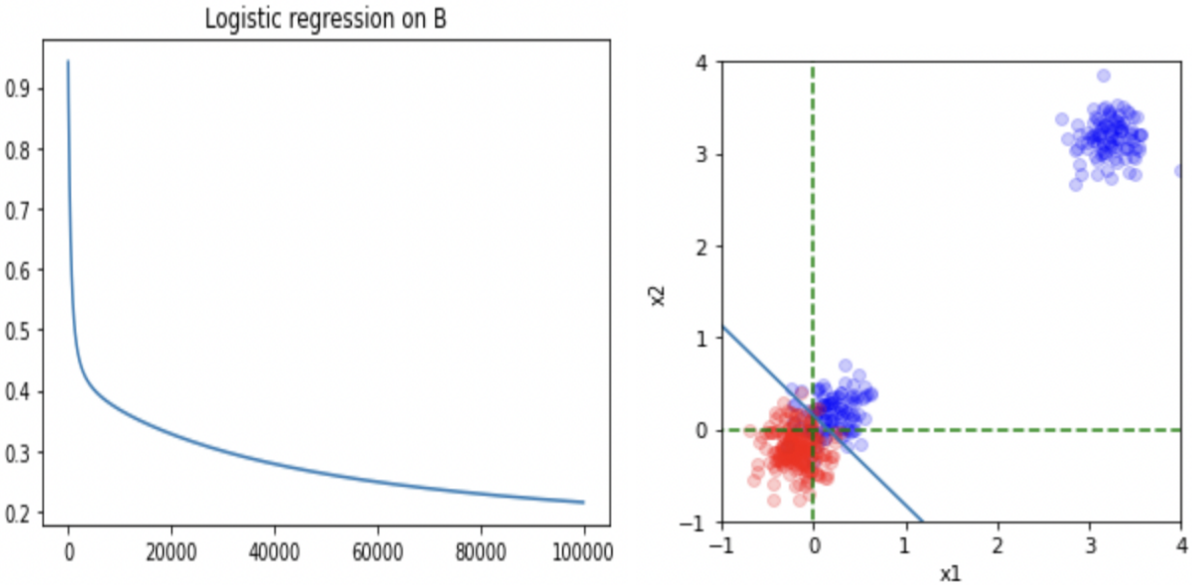

Figure 4: training loss and decision boundary of logistic regression on dataset B

Algorithm	Dataset A	Dataset B
Linear Regression	**0.92**	**0.75**
Logistic Regression	**0.92**	**0.9375**

Table 1: Accuracy of linear regression and logistic regression on datasets A and B

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Problem 2)

Best epoch	Validation Accuracy of best epoch	Test accuracy
46	0.919	**0.9232**

Table 2: best epoch, validation accuracy, and test accuracy of logistic regression on MNIST

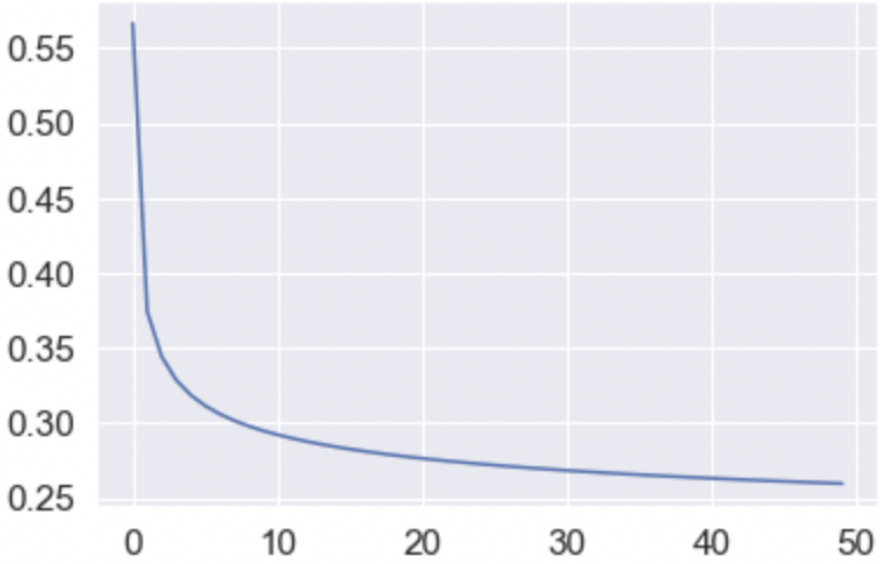

Figure 5: training loss vs epoch

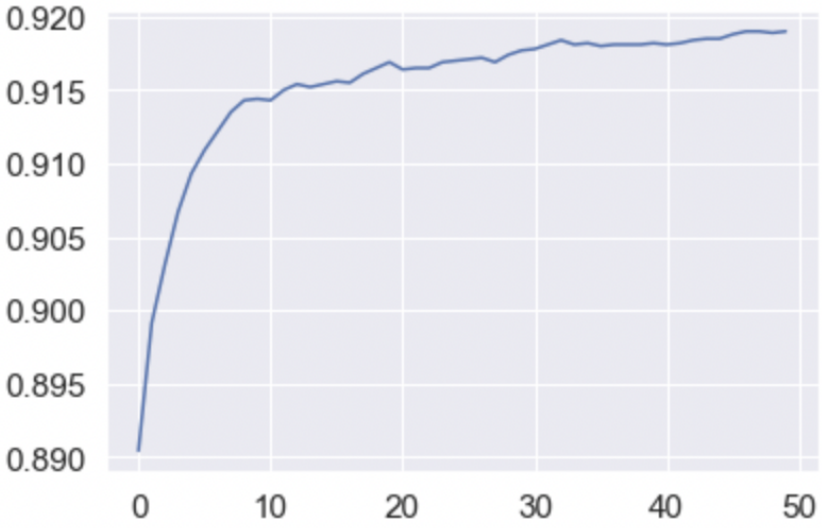

Figure 6: validation accuracy vs epoch

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Problem 3)

Question: Does the accuracy of the model differs between individual classes? Or does it have a similar performance in terms of accuracy for all the classes?

So in this task, the dataset consists of handwritten digits, and the classes are in the range of [0, 9], and the classifier has to recognize which class each image belongs to. Therefore, my guess was that due to the nature of the task, the accuracies are probably different. I plotted the confusion matrix and generated the actual accuracies per class to verify or reject this claim.

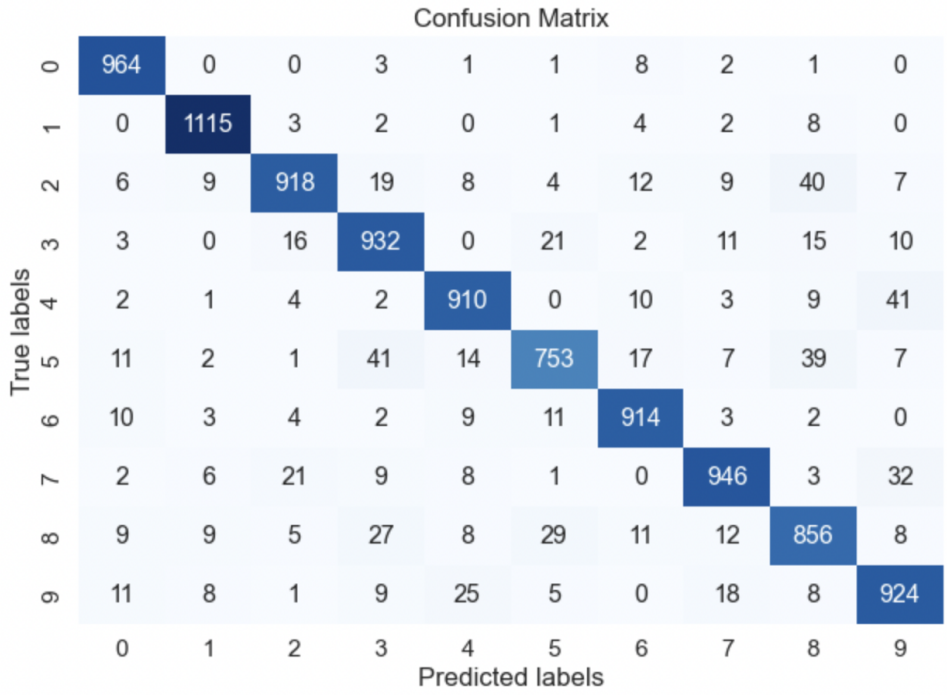

Figure 7 : confusion matrix of test data

Also, below is the per-class accuracy of the model on test data:

0 : 0.98367347
1: 0.98237885
2: 0.88953488,
3: 0.92277228,
4: 0.92668024,
5: 0.8441704 ,
6: 0.95407098,
7: 0.92023346
8: 0.8788501
9: 0.91575818

As you can see, it is easier for the classifier to classify zeros and ones. I believe the reason is that zeros and ones are quite similar to each other in different images and handwrtings, so it is indeed easier for the model to distinguish images belonging to this class. Furthermore, class “8” and “5” have the lowest accuracies

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comparing to the other classes. I believe the reason for this observation is that these classes have trickier shapes that may be easier to be confused with other classes. For instance, for class “8’’, we can see that digit 8 has a similar shape to digit 3. Therefore, we are seeing a relatively large number of images belonging to class “8” that are being mistakenly classified as “3”.

To conclude, the softmax regression model performs differently in terms of accuracy on digit classes. The differences can be justified by paying attention to the nature of the classes.