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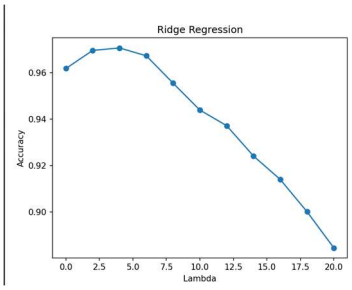


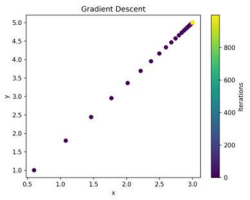
Best is when Lambda is 4 and the accuracy is 0.9708

The lambda changes have significant affect on the performance of the model.

Lets look at the affect of lambda, small ones make the regularization minimal, the model fits the data and has small overfitting.

Then, we reach the optimal lambda which has the best accuracy.

After the lambda = 4 we can see that the lambda overtakes the fitting and we can see underfitting and the model simplifies as lambda grows causing it a problem in catching the complexity of the data and preforming poorly.



Last value of x: 2.999999999999999

Last value of y: 4.999999999999998

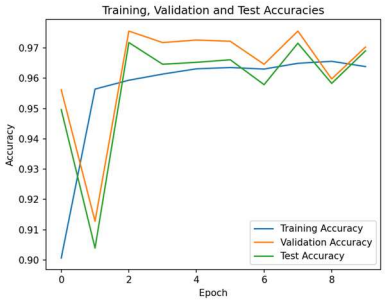
9.3 1)

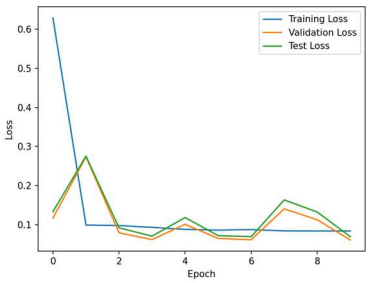
First model's lasts accuracy on validation set was : 0.9661

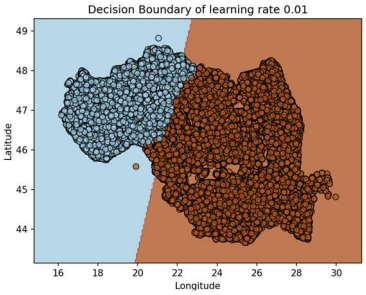
Second model's last accuracy on validation set was: 0.9762

Third model's last accuracy on validation set was : 0.9726

Therefore the best one was with learning rate of 0.01 model number 2.







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2) we can see that the training loss starts badly and converges as we iterate.

The hard decrease and stabilization indicates that we were able to minimize the loss function as desired.

The validation loss starts high and decreases it is less stable (as expected) but it still with slight deviations does converge too. What is mentioned above indicates that the overall performance of our model is improving and we are able to generalize the weight to handle minimizing loss function on validation set too.

The test loss looks the same as the validation graph it doesn't give us any new information more than what I mentioned above, the generalization of the model is good.

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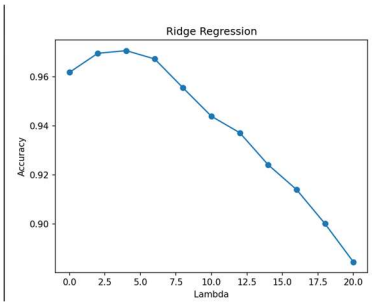
Looks good! With a very high accuracy as mentioned in the previous question.

3)Overall to achieve high accuracy in ridge regression we had to choose the lambda correctly,



However, When looking at the changes of learning rate on the accuracy of the models we see that It's a lot less sensitive to changes(ON OUR SPECIFIC DATA AND PROBLEM)

Also, overall the accuracy of both models was the same (at their peaks) around 97%

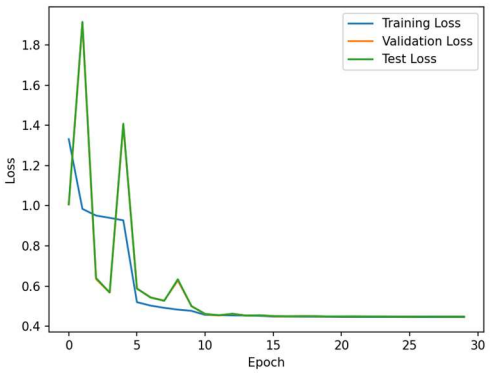
I do think logistic regression achieved a better result overall in less time so I do think it's the better model for this problem.

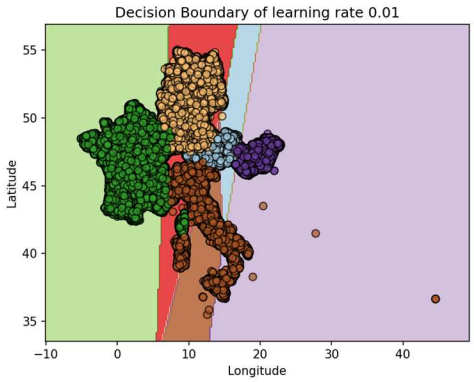
But, Ridge regression is the better method for penalizing data and avoiding overfitting (with the appropriate lambda chosen).

However, bad lambdas make overfitting and underfitting very quickly and such changes were not shown when we changed the learning rate in logistic regression.

I do ask myself how logistic regression will behave when the data was not binary classification but multiple classes classification.

Learning rate of : 0.01





Accuracy : 84%

Learning rate of: 0.001

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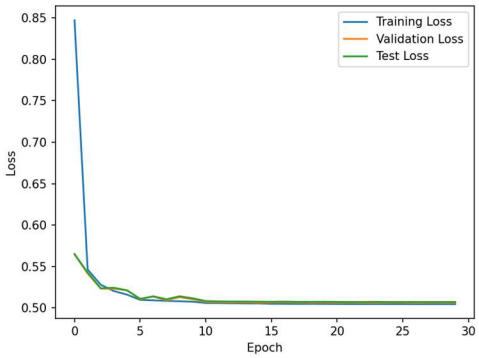
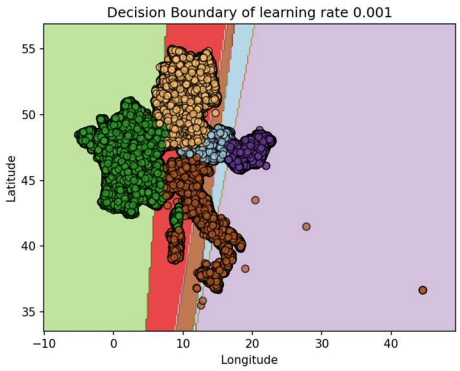
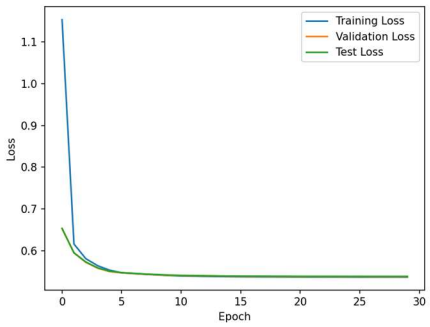
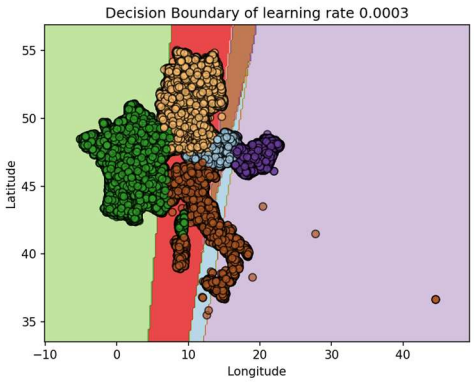




Accuracy : 79%

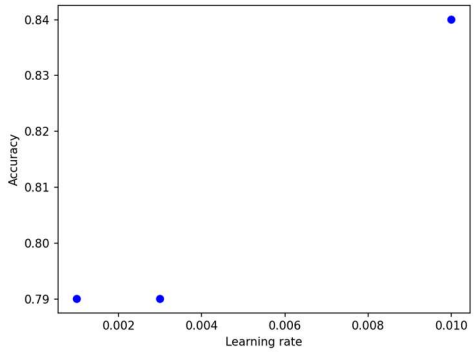
Learning rate of: 0.0003





Accuracy :79%

1)



The test accuracy on the validation set on the last epoch of the best model with $\lambda = 0.01 \quad accuracy = 84\%$

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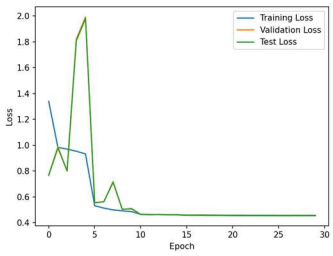
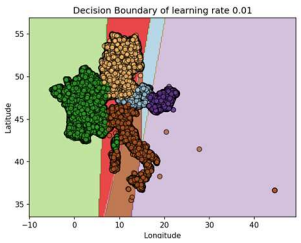
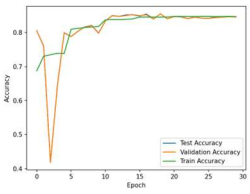
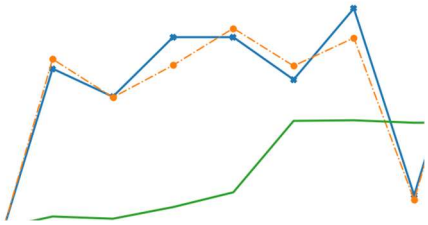
2)



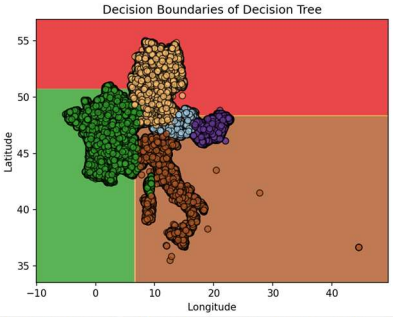




It looks like the validation accuracy and test accuracy are the same but they do deviate from each other as seen in this snippet



The model seems to generalize well from the training data,
The train accuracy seems to start at low values and steadily increases so the accuracy on the train data improves but also so does the accuracy on test and validation sets.
I don't think the model appears to overfit as we see that the accuracies overall go together.
I do think that the overall accuracy of the model is lower than what we saw in the previous question and even after many epochs we still see that the accuracy has hard time improving.




```
Accuracy of the tree on test set: 75.02357749135491 %
Accuracy of the tree on validation set: 74.97642250864509 %
```

I dont think that it generalized well because of the max depth of the tree it had hard time making complex decisions on the data.
Although it did achieve 75% accuracy but I think it indicates that our data is easy to "cluster" by linear lines.
I do think that the model from Q2 did achieve better results and was able to somewhat capture the data complexity better.I am sure that increasing the depthwill make a significant difference.

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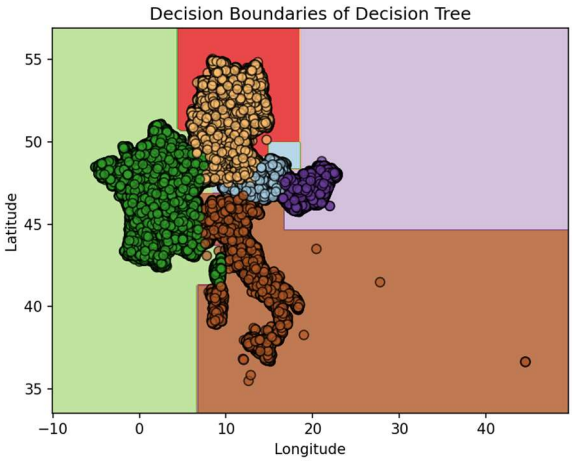

My god what a difference, this model is better, my opinion has changed , decision trees with deep enough depth are able to suit this task a lot better than logistic regression (when talking about multiple classification problem)

With Astonishing accuracy

```
Accuracy of the tree on test set: 99.67515456355443 %
Accuracy of the tree on validation set: 99.61752069579796 %
```

The decision tree model leaves dust for the logistic regression model and is better suited for this task. The ability to achieve such high accuracy on validation set means that the model was able to understand the complexity of the data and fit it perfectly even when given new data.

Bonus question2: the country is 🇮🇹🇫🇷🇩🇪🇸🇮