***LOGISTIC REGRESSION***:

We perform gradient descent on the loss function of randomly generated weights to find the weights that generate a minimum of loss. To do this, we have multiple parameters: max\_iters which is the maximum number of iterations during the gradient descent, and the learning rate which is the rate of descent. We found that 100 was a good value for max\_iters, as a value too big would lead to a sub-optimal runtime and not a notable improvement in results. For the learning rate, we initially tested with a huge range of different values like for example the powers of 10 from -5 to 5 to see which scale of values it should take. We then progressively narrowed the possible values to a little range: [,,, Afterwards, we use cross validation on these possible values to find the best value.

For logistic regression, the best value generates the biggest value

*SCORE WITHOUT CROSS-VALIDATION [lr=0.00001, max\_iters=50]:* accuracy = 77.28426395939087 ; macro F1 score = 0.63641554702023

*SCORE WITH CROSS VALIDATION FOR LEARNING RATE:* we set [max\_iters=50] and then perform cross validation in range (0.0001, 0.001, step=0.0001), finally we found an optimal value [lr=0.0007]

*SCORE WITH CROSS VALIDATION FOR MAX\_ITERS:* we then set [lr=0.0007] and then perform cross validation in range (10, 50, step=5) finally we found an optimal value [max\_iters=15] with scores -> accuracy = 78.2994923857868 ; macro F1 score = 0.6115677205882775

*CONCLUSION:* Using cross validation, we get a loss of ≈-4.06% for the macro F1 score and an improvement of ≈1.3% for the accuracy. To conclude, after a lot of tests from our side, we see that the results loss are very variant (using cross validation or not), so we just output our best results

**RIDGE REGRESSION**

We first did not used cross validation to find a good lambda and then use cross validation [#folds=4] around this value (we added the bias because we wanted to get best results as possible)

*SCORE WITHOUT CROSS VALIDATION*: we find that [lmda=10] get good accuracy, indeed we get a loss of 0.45390932372305587

*SCORE USING CROSS VALIDATION:* we then search the lmda in the range (0, 20) and we get loss of 0.4534581964034312 with [lmda=13]

*CONCLUSION*: We see that the ridge regression improves the loss result by ≈0.81% from standard linear regression (with bias) and using cross validation we can reach a ≈0.9% improvement, finally we see that the improvement is not so big, as expected the linear model is not making much overfitting

**FINAL RESULTS**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Linear Regression | Ridge Regression | Logistic Regression |
| CROSS  VALID. | / | ≈0.4534 MSE | ≈ 78.3% acc, ≈0.61 F1 score |
| NO CROSS  VALID. | ≈0.4576 MSE | ≈0.4539 MSE | ≈77% acc ≈0.63 F1 score |