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STAT 598 – Statistical Machine Learning

Assignment 2

1. Show that the ridge regression estimates can be obtained by ordinary least squares regression on an augmented data set.

Let the augmented matrices be denoted by: .

We can say that the ordinary least squares regression yields the estimate for parameter β given by:

Expanding the product and substituting for our values, we see that:

And that

Therefore, the estimation is given by:

This estimate Is the solution to the ridge regression with parameter λ.

2. a. Show that the form of P(Y|X) derived from the assumptions of a specific class of Gaussian naive Bayes classifiers is precisely the form used by logistic regression.

By the general Bayes’ Rule, we can say:

Let us denote as , and divide the numerator and denominator by the numerator. This yields:

Because of the conditional independence assumption in (c), we can rewrite the above as:

.

Looking to the summation, we see that:

Inserting this back into the original equation, we see:

Which can then be simplified to

**This is the parametric form used in the logistic regression equation.**

b. Is the new form of P(Y|X) implied by this more general Gaussian naive Bayes classifier still the form used by logistic regression?

Generalizing the Gaussian Naïve Bayes classifier by removing the assumption that the standard deviation does not depend on k, we first state that:

.

Looking again to the summation portion:

As a result, we see that P(Y=1|X) yields:

Where:

Note that in the general case, we will not have a situation where , so the quadratic term will not go to 0. **Therefore, this is no longer the form of the logistic regression.**

c. *See code for implementation of Gaussian Naïve Bayes on the spam dataset. I implemented both GNB by hand and by using the Sci-Kit Learn package in python.*

Classification report:

A computer screen shot of a blue screen

Description automatically generated

3. *See code for implementation of all four algorithms on the MNIST dataset provided.*

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