Report Template
FYS-STK4155 - Project 1

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Regression is a fundamental tool in physics and data science for approximating functions and making predictions. Particularly, polynomial regression illustrates key concepts like model complexity, overfitting, and the bias–variance tradeoff.

We studied how to fit polynomials to a specific one-dimensional function called Runge's function, which comes with an interesting phenomenon: oscillations at the edges of an interval when using higher-degree polynomial interpolation. This illustrates that increasing model complexity does not always improve accuracy.

To confront this challenge, we explored and compared various regression techniques: Ordinary Least Squares (OLS) regression, Ridge regression, and LASSO regression. We applied these to polynomial features of one-dimensional Runge function and evaluated their performance using resampling methods such as bootstrap and cross-validation. We also implemented several optimization methods, including Stochastic Gradient Descent (SGD) and its variants, and compared their results to analytical solutions.

Our results show that regularization through Ridge and Lasso can stabilize the fits and reduce variance compared to plain OLS. We also found that advanced optimizers like Adam and RMSProp converge faster than basic SGD. Finally, we demonstrated the bias–variance tradeoff, confirming that the key to the best performance lies in a balance between underfitting and overfitting.

Our findings emphasize the importance of regularization and optimization when applying regression methods.

I. INTRODUCTION

When you write the introduction you should focus on the following aspects:

- I'll write it in a second, just testing if I can git first lol

II. METHODS

A. Method 1/X

- Space for methods

B. Implementation

- Space for implementation

C. Use of AI tools

- ChatGPT has been used to generate bullet points to quicken the process of writing an abstract and introduction.

III. RESULTS AND DISCUSSION

- Here is the place for future results. So far we present 2 required figures:

Figure 1: My dog.

Figure 1 displays our professor's dog. I decided to leave this figure for scientific purposes.

Figure 2 presents the trade-off between bias and variance.

Figure 3 presents the MSE of a Ridge regression model for various polynomial degrees and lambda values

IV. CONCLUSION

- Our main findings are to be determined. However, lecture notes and previous assignments give us some insight into what we can expect to achieve.

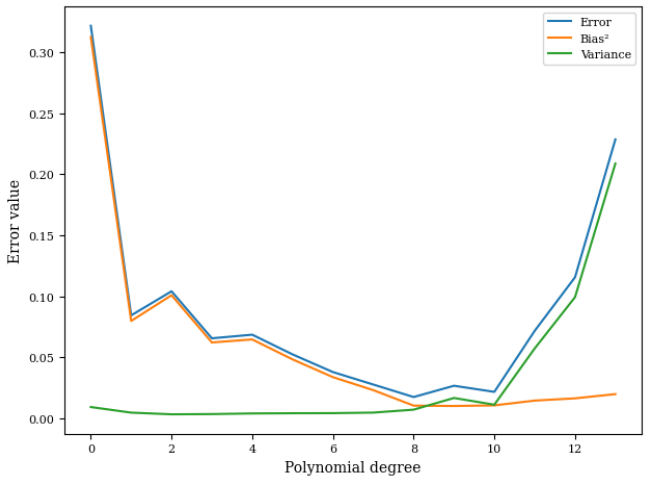

Figure 2: The bias-variance tradeoff.

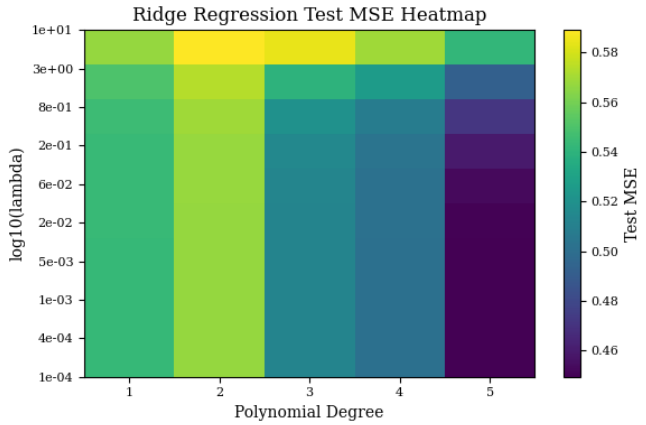

Figure 3: MSE values for Ridge Regression model vs. Polynomial degree and lambda.