Section 1: Polynomial Regression - Selecting Degree on a Fixed Validation Set
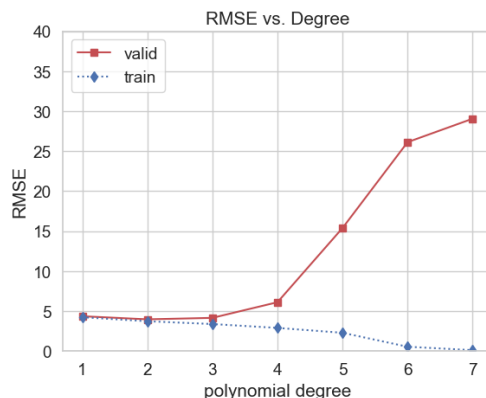

Figure 1: The RMSE for the train data steadily decreases while the RMSE for the validation set increases significantly with higher polynomial degree likely due to overfitting, all concepts we've seen in class. I'd choose a degree of 2 based on this plot.

(a)

Without preprocessing, the error becomes exponentially greater and leads to some features contributing more to a model's performance than others. This of course leads to less than optimal performance. By equalizing contributions by all features via preprocessing, we can ensure optimal performance by the model.

(b)

The values and their effects on mpg make sense. Increasing engine displacement would increase mpg, but very slightly. However, this differs means larger engine which results in more weight which would technically decrease

mpg, which is more accurate in a real-world setting.

(c)

The number of terms and the value of the terms are both increasing with each increase of the degree, suggesting direct correlations between the degree and the terms.

Section 2: Penalized Polynomial Regression - Selecting Alpha on a Fixed Validation Set
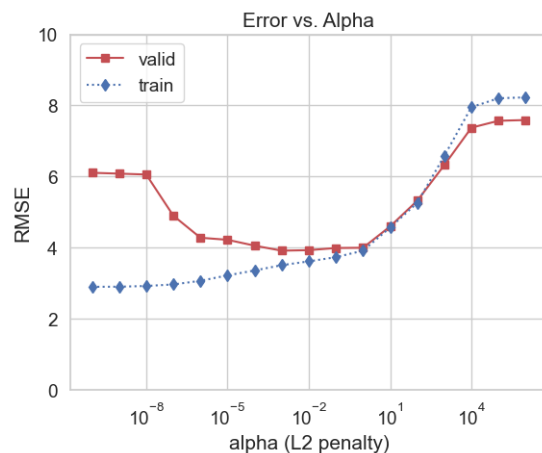

Figure 2: The plot looks typical to what we have seen in class, as alpha increases the RMSE decreases eventually reaching the absolute minimum before spiking back up due to over-penalized coefficients. I'd choose an alpha value of between 10^{-2} and 10^{1}.

(a)

The learned coefficients here are significantly less in magnitude than the degree-4 model I observed in 1c. However, there are the same amount of terms, just the values have overall gone closer to 0 on average (since there are negatives as well).

(b)

I would pick α which minimizes loss on the training set, but the problem with this is I'd run the risk of overfitting the training data.

Section 3: Penalized Polynomial Regression + Model Selection with Cross-Validation

	Best	RMSE
BL	-	7.105
1B	2	3.992
2B	.001	3.893
3B	2, .01	3.864

Table 1: The best is 3B, 2B, 1B, and then BL which makes sense given what we've learned in the course thus far. 3B optimizes both degree and alpha which allows it to control for overfitting the best whilst returning a more flexible model, which is the reason for its ranking.