STAT 463 - Assignment 4

Due Data: Saturday, April 1st, 2023

Data Description and Background

Rocket Motors, manufacturer of high-end sport bikes, just released its newest bike line, the Speed Demon. To get an understanding of the motorcycle's performance, the bike was driven on a closed course by a professional driver at a constant speed for 5 minutes and various data points recorded, among them being the fuel efficiency (measured in miles per gallon (MPG)). These calibrations runs were performed 200 times at a variety of speeds. Do the following:

1) Create a scatterplot of the data from the calibration runs, plotting the MPG on the vertical axis and speed on the horizontal axis (be sure to properly label your plot). Does there appear to be an association between the speed the bike is driven at and the MPG? If so, explain what the nature of the relationship seems to be. – 1.5 point
2) The National Highway Traffic Safety Administration (NHTSA) requires all vehicles marketed in the US to provide ranges for what the mean MPG is at a variety of speeds. Treating MPG as the response variable and speed as the explanatory variable, are enough of the model assumptions satisfied in order to fit a polynomial model to this data towards the prior purpose? If not, explain what must be done to address the deviations from the needed model assumptions (if necessary). – 2 points
3) After addressing any issues in part 2, fit a polynomial model to the data. Clearly explain the process with which you went about arriving at the order of the polynomial model you fit (you will need to fit several polynomial models and compare them). Explicitly write out the estimated model equation for the polynomial model you decided upon (on the transformed scales if data transformations were needed). – 2 points
4) On a scatter plot depicting the MPG on the vertical axis and speed on the horizontal axis (on their original, untransformed measurement scales), overlay the estimated model on the plot (in the event you transformed any of your variables, this may necessitate back transforming the polynomial model that was constructed on the transformed data). – 2 points
5) From the model constructed in part 3, can one conclude that there is a statistically significant relationship between MPG and the speed? Explain what procedure you used to determine so and why you arrived at your conclusion. – 1 points
6) Calculate the coefficient of determination for the model on the original measurement scale (if transformations were applied to the data, calculations of the various sums of squares requires back transforming the fitted values from the polynomial model on the transformed data to get the fitted values and residuals on the original scale). – 2 points
7) According to the model constructed in part 3, at what speed is the engine most fuel efficient (i.e. what speed does it have the highest MPG on average). Explain how you arrived at this value (this can certainly be ascertained analytically, but providing a numerically approximated value is also acceptable as well). – 2.5 points
8) On a scatter plot depicting the MPG on the vertical axis and speed on the horizontal axis (on their original, untransformed measurement scales), overlay 90% confidence bands for the mean MPG as functions of the speed (in the event you transformed any of your variables, this will necessitate back transforming the 90% confidence bands for the polynomial model that were constructed on the transformed data). – 3 points