Assignment 08

Regression Splines

This goal of this assignment is to give you experience using regression splines to model non-linear relationships. Turn in a printed version of your responses to each of the questions on this assignment. In addition, please adhere to the following guidelines for further formatting your assignment:

- All graphics should be set to an appropriate aspect ratio and sized so that they do not take up more room than necessary. They should also have an appropriate caption.
- Any typed mathematics (equations, matrices, vectors, etc.) should be appropriately typeset within the document.
- Syntax or computer output should not be included in your assignment unless it is specifically asked for.

This assignment is worth 15 points.

Motorcycle Accidents

For the first part of this assignment, you will use the file *mcycle.csv* (see the data codebook) to model how well helmets actually perform during a crash. It is of substantive interest to both discern the general shape of the underlying acceleration curve and to draw inferences about its minimum and maximum values.

Part I: Description

1. Create a scatterplot showing head acceleration as a function of time after impact.
2. An analyst has suggested fitting a 10th-degree polynomial model to the data. Add the fitted 10th-degree polynomial model to the scatterplot. Describe whether or not this model provides a good fit to these data. Is it a good fit in some regions of the data and not in others? Explain.

Part II: B-Spline: Specified Knots

Based on some prior information, an executive has suggested that the acceleration curve changes every ten seconds. Fit a B-spline with knots specified at every 10 seconds (up to 50 seconds). Use this fitted model to answer the questions in this section.

3. Create a scatterplot showing head acceleration as a function of time after impact (make these points somewhat transparent). Add the fitted spline model and the confidence envelope for the model to the scatterplot.
4. Based on the plot you created in Question #4, describe whether or not this model provides a good fit to these data. Is it a good fit in some regions of the data and not in others? Explain.

Part III: B-Spline Models: Uniform Knots

Rather than identify the knot locations, in this section, you will fit cubic B-spline models with a specified number of knots.

5. Explore the number of interior knots needed to model these data. To do this fit eight candidate models with 3–10 knots, respectively, using cubic B-splines. Report the AICc value for each of the eight models in a table.

Based on the results from the AICc evaluation, adopt the "best" candidate model. Use this model to answer the remaining questions in this section.

6. Report the knot locations for the adopted model.
7. Create a plot showing head acceleration as a function of time after impact (make these points somewhat transparent). Add the fitted spline model and the confidence envelope for the model to the scatterplot.

Part IV: Natural Spline Models: Uniform Knots

8. Explore the number of interior knots needed to model these data. To do this fit eight candidate models with 3–10 knots, respectively, but his time fitting a natural cubic spline. Report the AICc value for each of the eight models in a table.
9. Create a plot showing head acceleration as a function of time after impact (make these points somewhat transparent). Add the fitted natural spline model and the confidence envelope for the model to the scatterplot.

Model Adoption and Answering the Research Questions

10. Report the AICc for the B-spline model you adopted in Part III and the natural spline model you fitted in Part IV.
11. Based on the AICc values adopt a "final" model. Explain.
12. Evaluate the assumptions for the adopted "final" model. Include any plots you use to make this evaluation.
13. Use the plot of your fitted "final" model to describe the general shape of the underlying acceleration curve.
14. Identify and report the minimum and maximum values in the acceleration curve. Also report the 95% confidence limits for these values. (**2pts.**)