Math 543: Homework for Thursday May 8

Earthquake data These data are measurements recorded at seisometer locations for 23 large earthquakes in western North America between 1940 and 1980 (Pinheiro and Bates, 2000; Joyner and Boore 1981). The data are available within the nlme library as Earthquake.

Use the linear mixed model framework to analyze the variables related to maximum horizontal acceleration (the response variable). Consideration of the physics of energy dispersion suggests that transformations of one or more variable may improve the model fit. Some care is necessary when considering more than one random factor (e.g., random intercepts and random slopes) as the model may be overparameterized and yield highly correlated random effects. A model such is that is, or course, undesirable.

Notes

1. The Richter scale measures seismograph displacement (in principle) at a point 100 km distance from the epicenter of the quake; hence, there is one measurement per quake, which is generally viewed as a measure of strength. However, it tends to be a poor measure of inflicted damage as soil and bedrock formation have important roles in transmitting force from the epicenter
2. Acceleration is a measurement of horizontal movement of the ground and strongly reflects the observed force at a particular point. Acceleration is the response variable of interest.
3. Explanatory variables are Richter, distance, and soil type. It is of interest to determine which of these variables are related to acceleration.
4. For this problem, an appropriate analysis is an exploratory analysis consisting mostly of visual displays and a more formal model analysis that quantitatively confirms and supports what is revealed by the exploratory analysis.

Suggestions

1. Begin by examining the relationship between Richter and acceleration using all observations.
2. Look at the relationship between Richter and acceleration using only those quakes with at least 3 observations. Fit separate simple linear regression models for each quake and compare the slopes and intercepts using the lmList function in the nlme library
3. Examine the need (or lack thereof) of a linear mixed model containing both random intercepts and slopes versus and linear mixed model with only random intercepts, and also a conventional linear model (multiple regression)
4. Write a brief summary of your findings and interpret them. To what extent are earthquakes similar and dissimilar?

References

1. Joyner, Boore. 1981. Peak horizontal acceleration and velocity from strong-motion records including records from the 1979 Imperial Valley. California, earthquake. Bulletin of the Seismological Society of America **71**, 2011-2038.
2. Pinhiero, J.C., bates D.M. 2000. Mixed-Effects Models in S and S-PLUS. Springer, New York.