STAT 700
Homework 8 Problems
due Wed. Nov. 14

2 Problems. Please follow the Lab report directions off the homework web page and work in HW Groups.

1. We will consider the "politeness" dataset from Winter and Grawunder (2012) where there is interest in the relationship between the pitch (i.e., frequency) of a voice and the politeness. We can get this dataset from Bodo Winter's website and you can check out his website and tutorials for a more complete description of the dataset. Each subject gave multiple polite responses and multiple informal responses and the pitch response is measured as a mean pitch in Herz over the different utterances. We will ignore the the scenario variable.

```
> politeness <- read.csv("http://www.bodowinter.com/tutorial/politeness_data.csv")
```

The difference in politeness level is represented in the column called "attitude". In that column, "pol" stands for polite and "inf" for informal. Sex is represented as "F" and "M" in the column "gender". The dependent measure is "frequency", which is the voice pitch measured in Hertz

(a) Make a boxplot of the pitch by subjects using the formula `frequency ~ subject` Describe the variation.

(b) We can model the individual differences with a random intercept for each subject. It is important to check if there is any missing data and if there is, we can use the `na.action=na.omit` option in fitting models. You can check this by:

```
> which(!complete.cases(politeness))
```

Fit a linear mixed effects model for the frequency as function of the fixed effects of attitude and gender, and a random intercept for each subject. Use the LRT to test $H_0 : \sigma^2_{intercept} = 0$ against $H_1 : \sigma^2_{intercept} \neq 0$. State your conclusion and state which is the "best" model. Include and examine the plot of the residuals and the Q-Q plot of the residuals for the best model. Does it appear that the residuals are iid $N(0, \sigma^2)$

Note: We did not consider an interaction term, but if you did include it you should conclude that there is not a significant interaction.

(c) Try the option `weights=varPower()` in the `lme` function. (See the equation for the function given below in Problem 2, part (e) and Soybean Class Example. By default the variance covariate is given by the fitted values.) To determine the best model, we can use a LRT, but let's just examine the AIC values for each of the two linear mixed effects models. Which one is "best" based on AIC?

(d) Examine the summary of the "best" model from (c). Is there a significant difference in pitch between politeness levels? Is there a significant difference in pitch between Males and Females? Fill in the blank: Males and Females differ by about _____ Hz.

2. Generalized Least Squares: We will follow the example in Section 5.2 Weighted Least Squares from the GLS Description in the Course Documents Folder in the Lecture Material After Midterm Exam Folder. We will use the data `strongx` available in the `faraway` package.

(a) Use the `lm` function and fit the OLS linear model without weights. Include the four R diagnostic plots. Do you detect any pattern in the residuals when you examine the plot of the residuals versus fitted values?

(b) It states that it was possible to estimate the standard deviation of the response, so this dataset includes the column `SD`. Perform WLS with the `lm` function with `weights=sd^-2` option.

(c) Compare the fits from (a) and (b) by reproducing Figure 5.1.

(d) Suppose that you did not have the `SD`, then it might be reasonable to use `weights=energy^-2`. Perform WLS with these weights. Superimpose this fitted line to your Figure in (c). How do the 2 WLS fits compare?

(e) Now, let's follow the last line in Section 5.3 and try the `gls` function in `nlme` package. For fun, let's use the `varPower` function. This function represents the variance model of

$$Var(\varepsilon_{i,j}) = \sigma^2 |v_{i,j}|^{2\delta}$$

and we will use the option `weights = varPower(form = ~ energy)` which will use $v = energy$ in the above equation. Superimpose the fitted line to your Figure in (e). How does this fit compare to the other WLS fits?

(f) Finally, compare the AIC of all the 4 models. Which model is the "best" based on AIC?