STAT 700
Homework 9 Problems
due Wed. Nov. 16

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

1. Orthodontic Growth Curves (cont.): We will use the R dataset Orthodont (in the `nlme` library).

(a) Following the Rat Pup R code, make a new variable sex1 which is a 1 for Female and 0 for Male. Let's center the ages, so use `I(age-11)` in your R function calls. Fit a l inear mixed model using REML, that has fixed effects that include sex1, I(age-11), sex1:I(age-11) interaction, an intercept and a random effect for just the intercept. Call this `fit1`.

Note: You can read about centering in your textbook Section 2.9.5 Centering Covariates.

(b) 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 $N(0, \sigma^2)$?

(c) Examine the summary of the model `fit1` from part (a). Is there evidence to suggest that boys and girls have significantly different growth patterns? Explain.

(d) Make a plot of the standardized residuals versus fitted values by gender. (Hint: see the R code for the `ergoStool` data analysis and use `resid(., type=''p'')` option). Does it look like Males and Females have the same residual variance, σ^2?

(e) You can test part (d) as in the Rat Pup Lab, but for this homework just use your model from part (a) with the `VarIdent` option to allow for different residual variances for each gender. Call this model `fit1b`. Make a scatter plot of the standardized residuals versus fitted values for your heteroscedastic fit by gender. Now, does it look like Males and Females have the same residual variance?

(f) Which model `fit1` or `fit1b` in part (e) is the "best" model based on AIC? Plot the predicted values over time for all the subjects from the best model.

2. 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 Soybean Class Example). 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.