Stat 705, Spring 2015

1. **Blood pressure**: consider the data of problem 27.3 (p. 1164). Let Y_{ij} be the increase in diastolic blood pressure for rabbit i at dose j. Fit the model

$$Y_{ij} = \mu + \rho_i + \tau_j + \epsilon_{ij},$$

where where $i = 1, \ldots, 12$ rabbits and $j = 1, 2, 3, 4, 5, 6$ for the dose. Here, $\rho_i \overset{iid}{\sim} N(0, \sigma^2_\rho)$ independent of $\epsilon_{ij} \overset{iid}{\sim} N(0, \sigma^2)$.

   (a) What type of model/design is this? Hint: does every rabbit get all six doses?

   (b) Report the ANOVA table for the fixed effects (i.e. the Type III tests)

   (c) Report an estimate of σ_ρ. Also test $H_0 : \sigma_\rho = 0$ using `covtest` in `glimmix`. What is an estimate of $\text{corr}(Y_{i1}, Y_{i2})$?

   (d) Obtain spaghetti plots of the data and perform Tukey's test for additivity. Is an additive model reasonable? Qualitatively, what happens as dose increases within a rabbit?

   (e) Look at pairwise differences in the six doses adjusting for multiple comparisons.

   (f) Examine plots of the conditional residuals versus fitted values, and versus rabbit and dose. Is constant variance and normality reasonable for the ϵ_{ij}?

   (g) Obtain the fitted $\hat{\rho}_i$ and corresponding normal probability plot. Is normality among the rabbit effects reasonable?

2. **Insulin levels**: The file `insulin.sas` contains longitudinal data from a study on $n = 36$ rabbits; 12 rabbits were randomly assigned to each of 3 groups: group 1 rabbits received the "standard" insulin mixture, group 2 rabbits received a mixture containing 1% less protamine than the standard, and group 3 rabbits received a mixture containing 5% less protamine. Rabbits were injected with the assigned mixture at time 0, and blood sugar measurements taken on each rabbit at the time of injection (time 0) and 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 hours post-injection. Each data record in the file `insulin.dat` represents a single observation; the columns of the data set are (1) rabbit number, (2) hours (time), (3) response (blood sugar level), and (4) insulin group (1, 2, or 3).

   (a) What type of model/design is this? Hint: does every rabbit get all three insulin treatments?

   (b) **Qualitative assessment**: Obtain a profile (spaghetti) plot for each of the three insulin groups with a LOESS smooth superimposed on top. Describe what you see in terms of patterns of blood sugar reduction. Does there seem to be a difference among groups? Are the estimated mean functions (LOESS) approximately parallel?

   (c) **Formal assessment**: Fit a model that accounts for repeated measures over time, with factorial treatment structure:

$$Y_{ijk} = \mu + \rho_i + \alpha_j + \beta_k + (\alpha\beta)_{jk} + \epsilon_{ijk},$$

   where $i = 1, \ldots, 36$ rabbits, $j = 1, 2, 3$ for the treatment group, observed over time points $k = 1, 2, 3, 4, 5, 6, 7$. Here, $\rho_i \overset{iid}{\sim} N(0, \sigma^2_\rho)$ independent of $\epsilon_{ijk} \overset{iid}{\sim} N(0, \sigma^2)$. Report the ANOVA table for the fixed effects (i.e. the Type III tests). Is there a significant time by treatment interaction here? Does this surprise you given the spaghetti plots?

   (d) Report an estimate of σ_ρ. Also test $H_0 : \sigma_\rho = 0$ using `covtest zerog` in `glimmix`.

   (e) Look at pairwise differences in the three treatments *at each time point* and discuss significant differences adjusting for multiple comparisons. Is there a signficant difference in treatments at time zero? Should there be?

   (f) Examine plots of the conditional residuals versus fitted values, and versus rabbit, treatment, and time. Is constant variance and normality reasonable for the ϵ_{ijk}?

   (g) Obtain the fitted $\hat{\rho}_i$ and corresponding normal probability plot. Is normality among the rabbit effects reasonable?

3. **Summary reports**. Consider the data of problem 28.17 (p. 1205); these are Latin squares data. Perform an analysis of these data focusing on comparing the five reports in terms of helpfulness, blocking on executive and month. Are there significant differences in helpfulness among the five reports? If so, pairwise comparisons (with a lines plot) can help you figure out where these occur. Just use the standard SAS diagnostic panel from `plots=all` to assess assumptions.