MLM Nested Group Project Part 1 (Spring 2020)

0. We will use the classroom.csv data for this project.
   a. math1st will be the outcome of interest for this first part
      i. Recall that `math1st = mathkind + mathgain`
   b. Read in the data (R: store as `dat`)
   c. Fit all models using REML (not the default in STATA)

   d. It's best if you use lmerTest::lmer rather than lme4::lmer to call the MLM function. The former provides p-values for fixed effects in the summary.
   e. There are 2 common error messages one can get from lmer calls: failed to converge (problem with hessian: negative eigenvalue; max|grad| = ...); and singularity. They may both be problematic in a real problem, but the latter suggests that a variance component is on the boundary of the parameter space.
      1. In your discussion/writeup, consider the latter to be a "convergence problem" and ignore the former.
1. Estimate an Unconditional Means Model (UMM) with random intercepts for *both* schools and classrooms (nested in schools).
   a. Report the ICC for schools and the ICC for classrooms
   b. **WRITE OUT THIS MODEL** using your preferred notation, but use the same choice of notation for the remainder of your project
      i. Be mindful and explicit about any assumptions made.

2. ADD ALL School level predictors
   a. Report if adding the predictors **as a block** is justifed
   b. Report change in σ^2_ζ.

3. ADD ALL Classroom level predictors
   a. Report if adding the predictors as a block is justifed
   b. Report change in σ^2_η and change in σ^2_ϵ.
   c. Give a potential reason as to why σ^2_ϵ is reduced, but not σ^2_η?

4. ADD (nearly) ALL student level predictors (but not mathgain or mathkind, as these are outcomes in this context).
   a. Report if justifed statistically as a block of predictors
   b. Report change in variance components for all levels
   c. Give a potential reason as to why the school level variance component drops from prior model
   d. WRITE OUT THIS MODEL using your chosen notation.

5. a. Try to add a random slope for each teacher level predictor (varying at the school level; one by one separately - not all together)
   b. Report the model fit or lack of fit
   c. Why is it a bad idea to include a random slope on the housepov effect?
   d. Retry the above, allowing the slopes to be correlated with the random intercepts (still one by one)
   e. Report anything unusual about the variance components (changes that are in a direction you didn't expect) and any potential explanation for why those changes occured (hint: what did you add to the model?).

6. a. Try to add a random slope for each student level predictor (varying at the classroom level; one by one - not all together)
   b. Why is it a bad idea to include a classroom-level variable with random slopes at the classroom level?
   c. Retry the above, allowing the slopes to be correlated with the random intercepts. Report findings.

7. a. Try to add a random slope for each student level predictor varying at the school level (one by one - not all together)

b. Retry the above, allowing the slopes to be correlated with the random intercepts.
c. Report anything unusual about the variance components (changes that are unexpected)

8. a. Take the two predictors that had significant (at .05 level) random slopes, in the forms in which they worked (indep. or correlated) and add both to the model, and test for need of one conditional on needing the other.
   b. Is the more complex model (with both random slopes in it) justified?
   c. WRITE OUT THIS MODEL in your preferred notation

9. a. For UMM, write down: V_S, V_C, V_E for the three variance components (simply the estimates)
   b. For the most complicated (all fixed effects) random INTERCEPTS ONLY model, what are: V_C, V_S, V_E?
   c. By what fraction did these each decrease with the new predictors in the model?

10. Now consider the model with a random slope in ses.
    a. What are: V_C, V_S(ses=0), V_E ?
       i. We need to list 'ses=0' here, or we don't know how to use the slope variance.
    b. What are: V_S(ses=-0.50), V_S(ses=+0.5) ?

11. Now consider the model with a random slope in minority.
    a. What are: V_C, V_S(minority=0), V_E ?
       i. We need to list 'minority=0' here, or we don't know how to use the slope variance.
    b. What are: V_S(minority=0.25), V_S(minority=+0.50), V_S(minority=+0.75) ?

12. Now consider the model with a random slope in ses & minority.
    a. What are: V_C, V_S(minority=0,ses=0), V_E ? We need to list 'ses=0, minority=0' here, or we don't know how to use the slope variance
    b. In the last model, what is a "likely" (+/- 1 sd) range for η_{0jk}.
    c. Can we make a similar statement about ζ_{0k}?
    d. If you had a large value for η_{0jk}, would you expect a large or small or "any" value for the two random slope terms, ζ_{1k} and ζ_{2k} for ses and minority?
    e. If you had a large value for ζ_{0k}, would you expect a large or small or "any" value for the two random slope terms, ζ_{1k} and ζ_{2k} for ses and minority (discuss each separately)?