3. On one of the homeworks, we used simulation to evaluate the accuracy of methods for computing confidence intervals. This question deals with the reasoning behind the simulation for any particular method of creating a CI (only one method, not a comparison).

   (a) Considering one simulation run, what is the major difference between and the major advantage of using simulation (generating random data from a known distribution) over using observed data? (5 pts)

   In a simulation we Know what the right answer is so we can evaluate accuracy & precision of an estimator.

   (b) We repeat the same process many times, using a "for" loop. What do we save from each run of the loop? (5 pts)

   A TRUE/FALSE or 1/0 to indicate that the computed interval did (T) or did not (F) contain the true parameter value used to generate the data.

   (c) Upon completion of the loop, how do we compare results to the desired (let's say 95%) confidence level? (5 pts)

   Compute the proportion of successes (sum the 1's & 0's & divide by # iterations) and compare to 0.95. We worry a bit more about being too low than too high.

4. Consider a multilevel model for math achievement scores containing data on 7185 students from 160 different schools across the country.

   (a) Write out a model using a variable intercept for each school and including the following predictors which vary for each individual: minority (yes or no), gender (M or F), SES (socio-economic status of students family, taking any value from -4 to +4). Include distributions where ever appropriate, assuming normality.(10 pts)

$$y_i = \alpha_{j[i]} + \beta_1 I_{\text{minority}_i} + \beta_2 I_{\text{male}_i} + \beta_3 \, SES_i + \epsilon_i$$

$$\epsilon_i \sim N(0, \sigma^2) \qquad i = 1, \ldots, 7185$$

$$\alpha_j \sim N(\mu_\alpha, \sigma_\alpha^2) \qquad j = 1, \ldots, 160$$

(d) Variance within schools is estimated as 36 and school to school variance is estimated as 2. What are the estimated correlations for the scores of

i. two students from different schools? (4 pts)

0

ii. two students from the same school? (4 pts)

$2/(36+2) = 1/19$

5. ~~Suppose that in the above study (in #4) of math test scores researchers selected half~~ the schools at random a year before the math test was given and asked the students in these "treated" schools to watch the TV show Numb3rs. At the time of test taking, each individual's frequency of watching the Numb3rs show was recorded as low or high.

(a) Under what assumptions can we estimate a **causal** effect of asking students to watch the show on the math score? (5 pts)

Because "asking" was applied at random, no assumptions are needed to obtain causal inference back to the population of schools used in this study. We should adjust for any available pre-treatment variables.

(b) One of the researchers running the study suggests that we could improve the estimate of the effect of "asking" students to watch the show if we adjusted for the frequency of watching. Explain why that is not a good idea. (5 pts)

Frequency is measured post treatment, so adjusting for it might totally mess up our "asking" effect estimate.