**OEB 137 – Assignment 9**

**Due November 18, 2020 at 11:59 am (Eastern)  
  
Mixed-Effects Models and Time-Series Analyses**

1. Read in the “bat\_lice.csv” dataset. In this fictional dataset, researchers have randomly sampled bats from 4 random caves of the many caves in the southern Appalachian mountains and randomly chose 3 bat colonies from within each cave. The researchers are interested providing inference on how sex and bat health (indicated here by body mass index (BMI)) influence the number of lice that each bat carries. Use the lmer( ) function to run a mixed-effects model that describes variation in lice loads using the fixed main effects of sex and BMI and individual random intercepts of cave and colony, using the Restricted Maximum Likelihood option in lmer. Save the model as the object “mod1” and print a summary of mod1 using the summary( ) function. **(2 pts)**
2. Create a new model that adjusts the previous model to make the random effect for colony nested within the effect for cave. Save this new model as the object “mod2” and print a summary of mod2 using the summ( ) function from the jtools package (use the “digits=4” argument in the sum function to provide 4 significant digits in the output. **(1 pt)**
3. Now, adjust mod2 to add a random slope between lice and BMI for each different cave/colony random nested intercept term from mod2. Save this model as the object mod3 and print the summary using your preferred function. **(1 pt)**
4. Using the output from mod 3, interpret the coefficients for both fixed effects. Which random effect accounts for the most error in the model? **(2 pts)**
5. Read in the “maunaloa.csv” dataset, which provides the real NOAA data on atmospheric CO2 concentrations from the Mauna Loa research center. Use the ts( ) and decompose functions to create a deseasonalized monthly CO2 value for each month in the Mauna Loa dataset. Plot a blue line for the month.avg CO2 across time using the decimal date (dec.date). Add a red line for the deseasonalized CO2 that you’ve just calculated (**2 pts**). Look at the plot from the [NOAA site](https://www.esrl.noaa.gov/gmd/ccgg/trends/mlo.html) and be proud of the fact that you recreated such a famous figure (0 pts…sorry).
6. Use the forecast package to create a random-walk forecast (with drift=TRUE) of projected CO2 levels out until the year 2100 (hint, remember the units for forecasting are in months, not years) plot this forecast. Now, with your random-walk forecast object, use object$mean to get the forecasted CO2 concentration for October, 2050. (**2pts**)

Bonus: Adapt the hierarchical model code that Dan showed us in lab to create a 5-panel figure with the bat\_lice data that shows the relationship between BMI and lice loads for bats with each cave presented as an individual panel that has the global mean relationship presented as a dashed line, and a solid line representing the random slope and intercept for each cave in its respective panel. **(1 pt)**