BIO708 assignment 1

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BIO708 Assignment, Meaningful measurement, interpretability and comparability

Goal and Instructions: The goal of this assignment is to get you to think about your own approach to science, the role of scale of measurement, and meaningful effect sizes. Ultimately (I hope) this will aid how you approach statistical inference and ultimately you biologically inferences in addressing your questions. These questions are based on both the issues that we discussed in class as well as the readings. I am interested in knowing how you approach science and why. Please be clear and concise. You will not be graded on the length of your answers but on your depth of thought that will be evident from your responses. Please remember that this is an assignment and not a term paper. These are meant to be relatively short answer questions and not essays. Please remember to label axes on all plots. Titles on plots will be helpful as well.

Please provide the answers (both your code and your responses) in an .Rmd file and then rendered as either .html or .pdf. So I can check things, please also provide the data set.

Note: Feel free to either use base R functionality or tidyverse syntax for any of the questions below. Similarly for plotting either in base R or ggplot2.

Due Date: Friday Feb 23, 4:30 PM

1. Measurement

Using what you gleaned from our discussion of measurement theory (and if you need some review use the Voje et al paper), consider how measurement theory will help guide you in picking appropriate variables and how these will guide permissible analyses.

a. In particular I highly recommend replicating figure 1 from Voje et al. 2023 (with "theoretical context", "empirical relational structure", "numerical relational structure", "meaningful inferences") for your own data, so you can describe the scales for the variables under consideration.

b. After considering the scale of your variables, how might this influence the inferences you can make?

2. Effect sizes and meaningful magnitudes

You have been introduced to the idea of effect sizes being key quantities worth estimating (even though we have not entirely learned how to develop appropriate measures of uncertainty in many of them yet). We have discussed whether or not to have un-standardized measures (like raw differences, or *slopes/estimated parameters* without scaling the variable) **VS.** standardized measures (like *Cohen's d*, mean scaled measures of effects, log transformations, "slopes" for standardized continuous predictors and Pearson correlation coefficients). We have also briefly discussed (and you have watched a video) regarding the development of a "scale" of magnitudes of effects for your own field and questions regarding what magnitudes may or may not be meaningful.

As you learn more through the semester (and years to come in your field), these values may may change as you learn more. However, given the current knowledge you have of your domain of research and statistical inference (and effect sizes) please answer the following.

a. For your continuous response variable, and focusing on one (or at most two) predictors (continuous or factors) you will be using from your dataset for this class, provide what measures of effect you plan to use. Please explain your rationale fully, including any historical precedent in your field (what is typically used in studies similar to yours), and why you do (or do not) agree with the historical precedent.

b. If you are using a standardized measure of effect, how are you scaling your measure of magnitude? Using the mean $\hat{\mu}$ or standard deviation $\hat{\sigma}$? Total value ($\hat{\mu}_{total}$ or $\hat{\sigma}_{total}$), pooled standard deviation ($\hat{\sigma}_p$), scaled by estimate from a control group ($\hat{\mu}_c$ or $\hat{\sigma}_c$)? Something else entirely? Please explain your justification for this scaling/standardization. If you are not standardizing your effect size, please explain why.

c. For the effect size you have chosen please provide a few benefits (can overlap with what your wrote in a or b), but also a few possible "negatives" in how you (and the rest of the field) will ultimately be able to use this to advance science in your field (from your study in particular)?

d. Using what you learned from watching the video from Dr. Megan Higgs, on the Meaning of Magnitude, I would like you to develop a scale of magnitudes (Backdrop of meaning in magnitude) for your own work and for the measure of effect you are using. Please feel free to use any prior sources of literature from your field to help develop this. Explain your rationale for regions that you *a priori* consider to be unlikely of biological/environmental/clinical significance, **VS.** the "grey area" **VS.** regions of practical relevance?

e. Using the *BoMM* scale outlined in the figure below, how would you interpret, and what inferences would you draw (don't forget about the concept of the "counter-null") from the following estimates (1-7)? Each horizontal black line represents the 95% confidence interval (compatibility interval if you prefer a more generic term) for estimates from 7 distinct experiments testing the effect of different mutants compared to corresponding wild types for a trait of interest. For each experiment, please (in 1-2 sentences each) explain what you would infer in terms of meaningfulness and uncertainty (and anything else).

Based in part upon figure by Dr. Megan Higgs

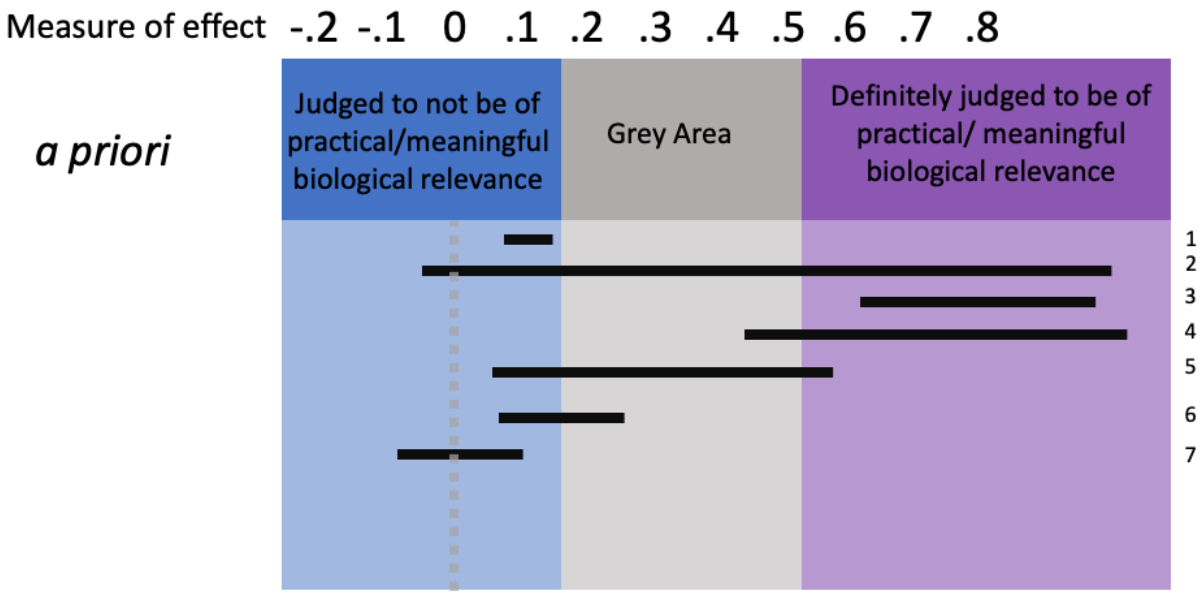

Figure 1: BoMM Figure