Systems Simulation
Alternative Activity
November 6, 2018

On November 8, we will have an in class activity related to designing and running experiments with a simulator. You can consider that activity to be a dry run for the "what if" questions you'll need to answer in your project. In preparation for that activity, please read the "research skills" chapter found with this activity write up. The document is aimed at psychology students, so the level of mathematical sophistication is basic. That's OK, because your activity will be to try to fill in some of the sophistication by making appeal to material you would have seen in course pre-requisites and filling in answers to some discussion questions to be provided below. In class on Thursday, we will review answers to ALL of these questions. However, you would be better prepared for that discussion, and likely get more value, if you take time to consider each of these questions beforehand. So, here we go:

1) In the first section (***The Goal of Inferential Statistics***), you'll find the following text:

   Inferential statistics is the mathematics and logic of how this generalization from sample to population can be made. The fundamental question is: can we infer the population's characteristics from the sample's characteristics? Descriptive statistics remains local to the sample, describing its central tendency and variability, while inferential statistics focuses on making statements about the population.

   The above statement is actually a very coherent differentiator between the worlds of *descriptive* and *inferential* statistics and is worthy of some consideration. With respect to the above statement, generate answers to the following questions. You may make reference to any source materials you like.

   a) What is a *population* and what is a *sample*. How are they related? Why would I treat them as separate entities? Is it always necessary to treat them as separate entities? Why or why not? Is it typical to treat them as separate entities? Why or why not?

   b) What does the statement "*Descriptive statistics remains local to the sample"* mean to you? Is it typical to be able to compute descriptive statistics for samples? Is it typical to be able to compute descriptive statistics for populations? Are there differences in your answers? If so, why? If not, why not?

   c) The above statement seems to limit "descriptive statistics" to measures of central moment and variability. Do you agree with this limitation? Why or why not.

2) In the second section (***Hypothesis Testing***), you'll find the following text:

The null hypothesis is the null condition: no difference between means or no relationship between variables. Data are collected that allow us to decide if we can reject the null hypothesis, and do so with some confidence that we're not making a mistake.

The need to "reject the opposite of what we're trying to establish" rather than just "prove what we're trying to establish" is often a point of confusion among those new to inferential statistics. The need to do this is actually VERY related to the philosophical problem of induction and the asymmetry in what it takes to prove a thing IS and what it takes to prove what a thing IS NOT when one is working with SAMPLES. In your own words, try to explain why it easier to use "more data" to better establish "differences" than it is to use "more data" to better establish "lack of differences".

Note: This is a conceptual, somewhat philosophical question. See what you can do with it prior to our discussion. Really getting THIS is the best way to ensure that you get why we mess with null hypotheses at all.

3) In the section titled ***Error Variance*,** the authors talk about systematic variance and residual variance. BOTH can be seen as resulting from the influences of hidden third variables. Dealing with BOTH is key to limiting (to the extent possible) the confounding influence of these hidden third variables (which we discussed in class at least once). Discuss some specific strategies one could use to help ameliorate issues related to the two kinds of *error variance.*

4) In the section titled ***p-values***, the authors provide the following text:

The null hypothesis can only be rejected when the probability of a Type 1 Error (error of rejecting it when you shouldn't) is less than .05 (the alpha level).

and later:

Statistical analysis software calculates a p-value that indicates the probability of committing a Type I Error based on the statistic (which it also calculates for you) and the sample size. The p-value can be any number between 0 and 1. If the p-value is less than alpha (generally .05), you may reject the null hypothesis.

The clear implication is that a "***p-value"*** has a "physical meaning". That meaning is, "the odds we'd be WRONG if we chose to reject the null hypothesis – at least the odds as they exist with respect to the observations (sample set) we made. Based on these observations, construct answers to the following:

a) A LOW p-value provides legitimate support for saying, with the observations we made, it is legit to reject the null hypothesis BECAUSE there is such a low chance of us NOT being able to justify the decision with the data we have. Does a HIGH p-value let us conclude that the null hypothesis is TRUE (I.E. not to be rejected?) or does it imply that we don't have rich enough data to be confident in any determination about the status of the null hypothesis? Why or why not?

5) The article does not mention it (as it is a topic more advanced than what is done in most stats for psychologist courses), but inferential tests come in two forms: parametric and non-parametric. Do a little side research on the differences between the two and, in your own words, summarize those differences and why they are important.