Homework 3

MA 590 Special Topics: Causal Inference

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Problem 1

Download the file "hintVSexp.csv" from (https://drive.google.com/open?id=15yQCMUNszztQNzyp40pQpm LRNn4z1JV4&authuser =acsales%40umich.edu&usp=drive_fs)[this link]. This is a group of 33 randomized experiments from the ASSISTments online learning platform in which users were randomized to be offered either a multi-step "hint" ($Z = 1$) or an "explanation" as to how to do the problem. The outcome Y is a binary indicator of whether they got the next problem correct or not. Here, we will treat this as one large experiment with 33 blocks, corresponding with particular problems in ASSISTments.

A

Use Fisher's method to estimate a p-value for the sharp null $H_0^{\text{Fisher}} : y_i(1) = y_i(0)$ for all i, and a 95% confidence interval for a constant effect. (As I have mentioned in class, constant effects don't make sense with binary outcomes. Let's ignore that problem for now and estimate one anyway.) Use any (valid) test statistic you like.

Solution

Something

B

Use Neyman's method to estimate a (possibly weighted) average treatment effect (τ_w), with a p-value for the null hypothesis $H_0^{\text{Neyman}} : \tau_w = 0$ and a 95% confidence interval.

Solution

Something

Problem 2

When dealing with grouped data, in some cases it makes sense to "group-mean-center" the data, i.e. subtract each group's mean observed outcome (pool treatment and control groups) from each of the group's outcomes. In other words, conduct analysis on $\tilde{Y_{ij}} = Y_{ij} - \bar{Y_j}$, rather than on Y_{ij}. In a stratified experiment, what effect will group-mean-centering the outcomes within strata have on the (Neyman-style) estimate and standard error? In a cluster-randomized experiment, what effect will group-mean-centering the outcomes within cluster have on the (Neyman-style) estimate and (cluster-robust) standard error?

Solution

Something

Problem 3

The "Fisherian" $1-\alpha$ confidence interval consists of all of the hypothetical constant effects τ such that the p-value testing the null hypothesis $H_\tau : y_i(1) - y_i(0) = \tau$ is greater than α.

Show that this is a valid $1-\alpha$ confidence interval, i.e. that if there is a true τ, the probability of estimating a CI that contains τ is $1-\alpha$. You may take for granted the fact that comparing fisherian p-values to α gives a valid α- level test, i.e. if you reject the null whenever $p < \alpha$, the probability of falsy rejecting a true null is α. (Though I strongly recommend convincing yourself that this is true–you just needn't write down your argument here.) Once you accept that Fisherian p-values give you valid α-level hypothesis tests, the proof is very simple, like two or three lines. Don't overthink it.

Solution

Something