PSC 504 | Prof. Matthew Blackwell | Harkness 307 | m.blackwell@rochester.edu

Homework 2

Hard copy due February 7th, 2013 at the start of class

1 Lady Tasting Tea

The classic example used by Fisher to demonstrate randomization inference is that of the Lady Tasting Tea. The stated premise is to evaluate the following claim:

> A lady declares that by tasting a cup of tea made with milk she can discriminate whether the milk or the tea infusion was first added to the cup. Fisher (1935)

To do this, Fisher proposes the following experiment: make six cups of tea, three of which are made "milk first" and three of which are made "tea first." Then, present these six cups to the lady in a random order. We can think of this as a completely randomized experiment with $N = 6$ and $N_t = 3$ treated units. We say that the milk-first are the treatment ($A_i = 1$) and that the lady's guess is $Y_i = 1$ when she guesses milk-first. Of course, the lady has potential responses under milk-first (treated, so $Y_i(1)$) and tea-first (control, so $Y_i(0)$). Note that the lady knows the design of the experiment so she knows there are three of each type. You should use the number of agreements ($\sum_i A_i Y_i + (1 - A_i)(1 - Y_i)$) as the test statistic.

1. Suppose the Lady had 6 agreements (out of a possible 6). Use the randomization distribution to perform a test of the sharp null hypothesis that the lady has no discriminating ability. Write down that null hypothesis and calculate the p-value of the one-sided test of that null?

2. Suppose instead that the Lady had 4 agreements. Calculate the p-value of this observed test statistic.

3. Suppose now that the Lady had 2 agreements. Calculate the p-value of this observed test statistic.

2 Randomization inference in the Olken experiment

For this problem, you will use the dataset from Ben Olken's "Monitoring Corruption" paper (slightly modified for use in the homework on the course website as `roads.RData`). You will reanalyze his experiment using Fisher's randomization method.

The goal of the paper is to examine the effect of sending invitations for council meetings to the broader community as opposed to just friends of the elite. Olken is interested in seeing if this encouragement of broader public monitoring will lead to lower levels of corruption in the form of missing expenditures.

In the invitations part of his experiment, Olken performed block (or stratified) randomization. Within each of the blocks (subdistricts in this case, variable name `kecnum`), he randomly selected N_{bt} villages to be treated from the N_b villages in the subdistrict.

1. Calculate the block-stratified difference in means of the "Missing expenditures - Unskilled Labor" variable (`lndiffeburuh`) between the invitations treatment (`und == 1`) and the control group (`und == 0`). To do this, calculate the difference in means within each subdistrict (`kecnum`) and then calculate the mean weighted by the number of villages in the subdistrict.

2. Calculate the size of Ω, the set of all possible treatment vectors (`und`) given the randomization scheme.

3. Write the sharp null hypothesis of no effect.

4. Approximate the randomization distribution under the sharp null of this block-stratified difference in means with 5000 draws from the randomization distribution. Create a nicely-formatted density plot of the randomization distribution with a vertical line indicating the observed value of the test statistic.

5. Use the randomization distribution to calculate p-values for the one- and two-sided tests. For the p-value on the two-sided test, compare this value to the p-value in Olken's paper (Table 11A, column 8), which is 0.098. What feature of randomization inference and his inferential approach might account for the difference between these two values?

6. Calculate the stratified rank sum statistic for the same outcome variable in the observed data, which is just the sum of within-stratum rank-sum statistics. Calculate an approximation to the randomization distribution and plot a density of the distribution along with a vertical line for the observed test statistic. In addition, report the p-values for the one-sided test.

7. Using the "inverting a test" method for the block-stratified difference in means, create a 95% confidence interval for an additive constant treatment effect.

8. What does this investigation tell you about the effectiveness of public monitoring on corruption?