Lab Six: Confidence Intervals and Hypotheses Testing

STA 111: Probability & Statistical Inference

Lab Objective

The purpose of the lab is to use R to obtain confidence intervals and perform hypotheses testing.

Lab Procedures

Let's look at two different data sets and answer questions that can be assessed with hypothesis tests/ confidence intervals.

1. Is caffeine dependence real?

The subjects are eleven people diagnosed as being dependent on caffeine. During one time period, these people were barred from coffee, colas, and other substances containing caffeine and instead took capsules containing their normal caffeine intake. During a different time period, they took placebo capsules with no caffeine. The order of the time periods in which the subjects took caffeine and placebos was randomized. The subjects, pill administrators, and testers did not know when they got each pill.

Subjects were assessed on the Beck Depression Inventory, which is a psychological test that measures depression. Higher scores on the test means the subject shows more symptoms of depression. Additionally, subjects were asked to press a button 200 times as quickly as possible, and their number of presses per minute was measured. The researchers are interested in whether being deprived of caffeine affects either of these outcomes. This is a matched pairs study, because comparisons of the treatments are made on the same people. The data are in the file *"Caffeine.txt"*. . *The data is in the same directory as previous lab files. Try to load the data in yourself this time. You can name the data whatever you want. You should look at the command from previous labs.*

Questions:

1. Generate new variables for the differences in depression scores and in beats. For both differences, take (caffeine score - placebo score) as the ordering. Note that you will create two new variables.

   To generate a new variable "var3" from the difference of two other variables "var1" and "var2" and to also add "var3" to your current data frame "Data", simply type `Data$var3 = Data$var1 - Data$var2`.

(a) (not handed in) Examine the distribution/histogram of depression score differences (caffeine - placebo). Does a normal curve seem like a reasonable description of the differences? You don't have to turn anything in for this part, just make the plots to check assumptions. If the normal curve seems like a reasonable fit, you can use the t-test approach. Otherwise, because the sample size is small, you have to use other methods that we have not covered in this course.

Let's assume for the purpose of this lab that the normal distribution is a reasonable assumption.

(b) (do this by hand) Test the null hypothesis that caffeine addicts deprived of caffeine have the same population average depression score as caffeine addicts not deprived of caffeine. Write on your lab report your hypotheses, the value of the test statistic (show the numerator and denominator that go into the test statistic), the p-value, and your conclusions. Use a two-sided alternative hypothesis, since we don't know whether caffeine deprivation will make people more or less depressed.

Notice that one of the two variables you created contains all the information you need to do this!

(c) (do this in R) To do a t-test in R for means, we can use the `t.test` command. This command can be used to perform a variety of mean comparisons, including one-sample, two-sample, and two-group. The syntax for a (paired) two-sample test is: `t.test(var1, var2, paired=TRUE)` which tests whether the means of "var1" and "var2" are equal. t.test will report the means of each variable and a confidence interval for the mean difference between the two variables. Do the results match-up with your results from (b)?

The common options available for the t.test command can be seen below:

t.test(x,y, alternative = c("two.sided","less","greater"), mu = 0, paired = FALSE, conf.level = 0.95). and you can choose the options desired.

For a t-test on a single variable, y (or var2) is set to NULL by default so you can just ignore that piece.

2. Give a two-sided 90% confidence interval for the difference in the population average of beats for caffeine addicts not deprived of caffeine and the population average of beats for caffeine addicts deprived of caffeine. Is there sufficient evidence to say that caffeine deprivation alters addicts' motor speed? You can use the t.test command again since it gives confidence intervals by default. Remember to change the confidence level desired from the default (95%).

2. Subliminal Messages and Their Effects on Math Test Scores

A subliminal message is below our threshold of awareness but may influence our behavior. Can subliminal messages affect the way students learn math? A group of students who had failed the mathematics part of the City of New York Skills Assessment Test agreed to participate in a study of this question. The data were originally collected in a study by John Hudesman, and the study is described in Moore (2000, p. 400).

All students received a daily subliminal message flashed on a screen too rapidly to be read consciously. The students were randomly assigned to receive one of two messages. The treatment group received the message, "Each day I am getting better in math." The control group received the neutral message, "People are walking on the street." All students in both groups took a pretest, went to a summer math skills program, and then took a post-test.

This is a study involving inferences for the difference in means of separate groups. It is not matched pairs because there are two separate groups: the students who got the subliminal message, and the students who got the neutral message. The data for the students' test scores are in the file *"Subliminal.txt"*. People in the subliminal group have the code "T", and people in the neutral message group have the code "C".

Again, try to load the data in yourself. You can call the data whatever you want.

Questions:

3. (a) (not handed in) In this problem, the outcome variable is the improvement in test scores. For each group, examine the distribution of improvement scores. Do normal curves appear reasonable to describe the distributions of improvement scores in each group?

   Hint: you might find the "which" function useful in differentiating between the two groups.

   If the data in both groups roughly follow normal curves, we can proceed with the significance test. Otherwise, because the sample size is small, you have to use methods that we have not learned in this course.

   Again, let's assume that the normal distribution is a reasonable assumption.

   (b) (do this in R) The researchers claim that the positive subliminal message improves test scores.Test their claim using the change in test score (post-test score - pre-test score). for the subliminal and neutral message groups. Write your hypotheses, the value of the test statistic (show the numerator and denominator that go into the test statistic), the p-value, and your conclusions. You can get the test-statistic and p-value from the R results. Use a one-sided alternative hypothesis. Once again we can take advantage of t.test. However, instead of doing a two-sample test, we'll do a two-group test. The syntax for a two-group test is: `t.test(var1 ~ var2, paired=FALSE)` where "var1" is the outcome and "var2" is the group variable.

4. Give a 99% confidence interval for the difference in average improvement when viewing the positive subliminal message versus when viewing the neutral message. Again, you can use the t.test for this. Explain in one sentence what this confidence interval tells you about the effectiveness of the subliminal message versus the neutral message.

COMMENTS ON THIS PROBLEM: These conclusions are valid for the subject material, message, and student populations in this study. However, they may not generalize to other subject material, messages, or other populations. Additional studies involving other subject material, other messages, and other populations are needed before we can feel secure with broad generalizations.

Reference: Moore, D. *The Basic Practice of Statistics*. New York: W.H. Freeman and Company, 2000.

This ends the lab. Remember to turn in your lab reports on Sakai.