BACS HW - Week 5

Question 1) Install the "manipulate" package: `install.packages("manipulate")`. Then, download the R script `t_power.R` and save it in the same directory as your homework project. Open and run `t_power.R` using RStudio's menus: *`Code > Source`*; you will see a simulation of null and alternative distributions of the t-statistic, along with significance and power. If you do not see interactive controls (slider bars), press the gears icon (⚙) on the top-left of the visualization.

Recall the form of t-tests, where $t = \frac{(\bar{x} - \mu_o)}{s/\sqrt{n}}$

Let's see how hypothesis tests are are affected by various factors:x

diff: the difference we wish to test ($\bar{x} - \mu_o$)

sd: the standard deviation of our sample data (s)

n: the number of cases in our sample data

alpha: the significance level of our test (e.g., alpha is 5% for a 95% confidence level)

Your colleague, a data analyst in your organization, is working on a hypothesis test where he has sampled product usage information from customers who are using a new smartwatch. He wishes to test whether the mean (x_i) usage time is higher than the usage time of the company's previous smartwatch released two years ago (μ_o):

> H_{null}: The mean usage time of the new smartwatch is the same or less than for the previous smartwatch.
>
> H_{alt}: The mean usage time is greater than that of our previous smartwatch.

After collecting data from just n=50 customers, he informs you that he has found diff=0.3 and sd=2.9.
Your colleague believes that we cannot reject the null hypothesis at alpha of 5%.

Use the slider bars of the simulation to the values your colleague found, and confirm from the visualization that we cannot reject the null hypothesis. Consider the scenarios (a – d) independently using the simulation tool. For each scenario, start with the initial parameters above, then adjust them to answer the following questions:

i. Would this scenario create systematic or random error (or both or neither)?
ii. Which part of the t-statistic or significance (diff, sd, n, alpha) would be affected?
iii. Will it increase or decrease our *power* to reject the null hypothesis?
iv. Which kind of error (Type I or Type II) becomes more likely because of this scenario?

a. You discover that your colleague wanted to target the general population of Taiwanese users of the product. However, he only collected data from a pool of young consumers, and missed many older customers who you suspect might use the product *much less* every day.
b. You find that 20 of the respondents are reporting data from the wrong wearable device, so they should be removed from the data. These 20 people are just like the others in every other respect.
c. A very annoying professor visiting your company has criticized your colleague's "95% confidence" criteria, and has suggested relaxing it to just 90%.
d. Your colleague has measured usage times on five weekdays and taken a daily average. But you feel this will underreport usage for younger people who are very active on weekends, whereas it over-reports usage of older users.

Question 2) Let's return to the *strictly fictional scenario* (but with real data) from last week's Verizon dataset. Imagine this time that Verizon claims that they *take no more than 7.6 minutes on average* (single-tail test) to repair phone services for its customers. The file `verizon.csv` has a recent sample of repair times collected by the New York Public Utilities Commission, who seeks to verify this claim at 99% confidence.

a. Recreate the traditional hypothesis test of last week using high-level built-in functions of R:
   (you may have to see the R help documentation, google how to use them, or ask for help on Teams)
   i. Use the `t.test()` function to conduct a one-sample, one-tailed t-test:
      report 99% confidence interval of the mean, t-value, and p-value
   ii. Use the `power.t.test()` function to tell us the power of the test
b. Let's use *bootstrapped hypothesis testing* to re-examine this problem:
   i. Retrieve the original t-value from traditional methods (above)
   ii. Bootstrap the null and alternative t-distributions
   iii. Find the 99% cutoff value for critical null values of t (from the bootstrapped null);
      What should our test conclude when comparing the original t-value to the 99% cutoff value?
   iv. Compute the p-value and power of our bootstrapped test