BACS HW (Week 9)

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 95% CI)

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 50 customers, he informs you that he has found diff=0.3 and sd=2.9, at n=50.
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 at 5% significance. Consider the following 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) A psychological research paper has published an experiment to see if emotion affects our perception of color on different *color-axes*. Participants viewed one of two videos: either the famous death scene in the Lion King, or a video of a desktop screensaver — let's call these the *sad* and *neutral* conditions, respectively. Afterwards, participants performed a color discrimination task requiring them to classify colors along the *red-green color-axis* and *blue-yellow color axis*. The dependent measures are the *accuracy* in each of the color conditions (red-green and blue-yellow). The researchers found some potential difference in the blue-yellow accuracy of sad versus neutral participants, but not so for red-green accuracy. Let's examine their findings more carefully. You will find the experiment data in the file `study2Data.csv` on Canvas:

```
experiment <- read.csv('study2Data.csv', header=TRUE)
BY_data <- with(experiment, data.frame(Subject, Axis='BY', Emotion_Condition, ACC=BY_ACC, SAD_ESRI))
RG_data <- with(experiment, data.frame(Subject, Axis='RG', Emotion_Condition, ACC=RG_ACC, SAD_ESRI))
```

a. Visualize the differences between blue-yellow accuracy (`BY_ACC`) and red-green accuracy (`RG_ACC`) for both the sad and neutral viewers (`Emotion_Condition`). You are free to choose any visualization method you wish, but only report the most useful visualizations and any first impressions.
b. Run a t-test (*traditional*) to check if there is a significant difference in blue-yellow accuracy between sad and neutral participants at 95% confidence.
c. Run a t-test (*traditional*) to check if there is a significant difference in red-green accuracy between sad and neutral participants at 95% confidence.
d. *(not graded)* Do the above t-tests support a claim that there is an interaction between emotion and color axis? (i.e., does people's accuracy of color perception along different color-axes depend on their emotion? Here, accuracy is an outcome variable, while color-axis and emotion are independent factors)
e. Run a *factorial design* ANOVA where color perception accuracy is determined by emotion (sad vs. neutral), color-axis (RG vs. BY), and the interaction of emotion and color-axis.

```
all_data <- rbind(BY_data, RG_data)
aov(formula = ACC ~ Axis + Emotion_Condition + Axis:Emotion_Condition, data=all_data)
```

Are any of these three factors (emotion/color-axis/interaction) possibly influencing color perception accuracy at any meaningful level of confidence?

Required Readings: We are soon going to take a look at some geometric interpretations of statistics. Please review some basic geometric concepts below to prepare for our next class.

Angles using radians versus degrees: https://www.mathsisfun.com/geometry/radians.html

Basic Trigonometry: https://www.mathsisfun.com/sine-cosine-tangent.html