Advanced Statistics, Summer 2022

Homework 1, 04.05.2021

Required data files for exercise #5 are provided for you individually in a zip-file numbered with your homework ID. You will find your homework ID in the file "Homework ID.pdf". All datasets are in CSV format (comma separated values) with the first line as heading, and as Excel sheets.

You can use any programming language or statistical package that you are familiar with (e.g. MATLAB, python, R, SPSS, …).

Please double-check your solutions. Wrong solutions will be sent back for corrections.

Please, submit the **solutions and the codes** that you used in **one PDF file** labeled "Your Name - Homework 1" to me at: steffen.gais@uni-tuebingen.de.

Send your solutions until Wednesday, 11.05., 11:00 am.

Please use "ADVSTAT" in the subject line of your emails.

Solve these tasks on your own. Copy/paste solutions from others will not be accepted!

1. You want to compare the height of men and women. You measure for the males (n = 814) a mean of $\bar{x}$ = 177.7 cm with a variance of s^2 = 49.0 cm^2. For the females (n = 854) you measure $\bar{x}$ = 165.1 cm with s^2 = 38.4 cm^2.
    a. Calculate Cohen's d.
    b. What is the formula?
    c. How would you label this effect according to Cohen's suggestions for effect sizes in the behavioral sciences?

2. You hear that a study (randomized, controlled trial with two independent groups) found a small sized effect of a drug (n = 72) against placebo (n = 72) of d = 0.2. Is this effect significant with α=0.05? Please state your reasoning. *(Standard deviations of both groups are assumed equal.* ***You can solve this problem just by looking at the formulas for d and t. You should not need the help of a computer.****)*

3. You compare a measurement g in a sample of male-female siblings (N=1292 pairs). You measure a g_{male} = 8.66 with s = 3.2, and a g_{female} = 8.45 with s = 2.8. The correlation of g scores is assumed to be r = 0.47. What is the effect size for the difference between groups? (*This website might help you: https://www.psychometrica.de/effect_size.html*)

4. You plan an experimental study with three groups to test whether (1) daily physical training or (2) daily ingestion of chocolate improve mood compared to (3) a control group. You are interested in an effect only if it explains more than 10% of the total variance of participants' mood. Using a one-way ANOVA, you want to have at least 90% chance of finding such an effect if it exists, and you want to have no more than 5% probability of a false positive finding if no effect exists.
    a. How large should your sample size be?
    b. Provide a plot of the relation between statistical power and sample size.
    c. What is the required sample size, if you want to detect a small effect (effect size f=0.1)?

    *(The free software G*Power [www.gpower.hhu.de] can be very helpful here. It can also calculate effect sizes based on variances. Remember that the total variance is comprised of the variance of the effect and the variance within groups!)*

5. You have questionnaire data from 2 groups of 50 participants. The questionnaire has 40 items. You find the group means, standard deviations and significances of the group differences in Table1.csv / Table1.xlsx.

    For your information: In the population, there is a medium [d=0.5] true effect in 10 of the items. These are indicated in the column 'PopulationEffect'. You could not know this in real data.

    Using 1. **no correction** for multiple testing, 2. **Bonferroni FWE** correction, 3. **Bonferroni-Holm** FWE correction, and 4. **Benjamini-Hochberg** FDR correction:
    - Which items differ significantly using α=0.05.?
    - How many items are false positives? Which items?
    - How many items are false negatives? Which items?

6. BONUS QUESTION (*not required*): You read a published study with a p-value of 0.048 (2-sided t-test) and you plan to replicate this study exactly (identical n). What is your (approximate) chance of also getting a significant result (i.e. your statistical power)? To solve this, you can argue with plots of H0 and H1 distributions. Where is the peak of the H1 distribution?