Homework 7

Due Tuesday, November 10

Please either give the assignment to Loraine at the CDS or send it via email to the graders **before noon**.

1. *Short questions.* Justify your answers.
   a. If we do not reject the null hypothesis, does this mean that it is probably true?
   b. Can we interpret the p-value as the probability that the null hypothesis is true?
   c. At an exploratory phase, where you just want to get an idea of possible effects that show up in the data, what would you rather use: a test with large size and large power, or a test with small size and small power?
   d. If you want to make sure that an effect that you observe is not just due to random noise, what would you rather use: a test with large size and large power, or a test with small size and small power?
   e. What is the problem of applying Bonferroni's method if you are testing a very large number of hypotheses?
2. *Cars* A company is evaluating how durable their cars are. The time until a car breaks down for the first time is well modeled as an exponential random variable. The company wants to make sure that the cars won't have any problems at least for a year on average.
   a. Propose a hypothesis test based on thresholding the test statistic $\max_{1 \leq i \leq n} t_i$, where t_1, t_2, $\ldots$, t_n are times for which different cars suffered their first problem (consider them iid).
   b. What is the power function of your hypothesis test in terms of n and the threshold?
   c. Plot the power function for different values of n and the threshold. Comment on what happens for small and large values of n.
3. *Sign test.* Your friend is convinced that in general the left ear of most people is longer than the right ear. You measure the ears of some of your other friends and obtain the following data (in inches).

Left	2.4	2.7	3.2	2.3	2.0	2.6	3.2	2.3	2.9	2.3
Right	2.2	2.6	3.3	2.2	2.1	2.5	3.1	2.5	2.7	2.2

   a. If you use a test statistic that counts the number of people for which the left ear is longer than the right ear, what would you choose as a null hypothesis?
   b. Give an expression for the size of a test that thresholds the test statistic as a function of the threshold.
   c. What is the p value of your data?
4. *Permutation test for the median.* Complete the code in hw7_pb4.py, which applies the permutation test to the cholesterol data that we saw in class for two test statistics: the difference of sample means and the difference of sample medians.

a. Report your p values for the difference of the sample median.

b. The median is a statistic that is more robust to outliers than the mean. Interpret the p values you obtain for the difference of the sample means and the sample medians by referring to the histogram of the cholesterol data.

5. *Most published research findings are false.* Read the article *Why most published research findings are false* by John Ioannidis.

   a. Write a brief summary of no more than 10 lines. If there are technical aspects that you don't understand that is fine, just explain the gist of it.