

**Math4397/6397**

**Problem Set 11, due Thursday Dec 3**

Problem 1. Refer to the data from Problem 2 in Set 10. Re-use your computations for the tables to perform Fisher's test against having an unequal mortality rate in the two groups (two-sided). Compare the  $p$ -value resulting from this test with that from a test based on the  $\chi^2$ -statistic.

Problem 2. A small study was done to compare how well students with different majors do in an introductory statistics course. Seven majors were found: biology, psychology, sociology, business, education, meteorology and economics. At the end of the course, the students were given a special test to measure their understanding of basic statistics. Then a series of  $t$ -tests were performed to compare *every pair* of majors. Thus, biology and psychology majors were compared, biology and sociology majors, psychology and sociology majors, etc., for a total of 21  $t$ -tests.

Simulate this study assuming all majors do about the same. Assume there are 20 students in each major, and that scores on the test have a normal distribution with mean  $\mu = 12$  and standard deviation  $\sigma = 2$ . Use the computer to generate random test scores that are normally distributed for biology majors, then do it a second time to get a sample for psychology majors and so on, for 7 samples (one for each major).

- List the 21 pairs of majors and perform the 21  $t$ -tests.
- In how many of the tests did you reject the null hypothesis at  $\alpha = 0.10$ ?
- Use the Bonferroni procedure to pick a significance level  $\alpha^*$  for each comparison so that the probability of a familywise error under the null hypothesis is no larger than 0.1. Perform the tests and report.

Problem 3. Researchers comparing fMRI signals between a resting state and a active state in 10 different regions of the brain, found the following  $p$ -values resulting from a test for equal activity:

Region	1	2	3	4	5	6	7	8	9	10
P-value	.081	.011	.053	.0140	.016	.045	.046	.050	.003	.053

- Controlling the FWE of .05, which regions would be rejected?
- Controlling the FDR at .05, which regions would be rejected? (Interpret your results.)

Problem 4. Consider the Wilcoxon-Signed Rank Test with  $n = 4$ .

- List all possible associations of signs with the ranks 1, 2, 3, 4 and list corresponding values of  $T^+$  and  $T^-$ .
- Obtain the probability distribution of  $T^+$  and  $T^-$  for  $n = 4$  using a.

- c. From b., calculate  $E(T^+)$ ,  $\text{Var}(T^+)$ . Also compare with the values obtained from the formulas for a large  $n$ .

Problem 5. **For students enrolled in Math6397 only.** In the new teams, work out the solution to Project 3, linked from the course webpage.