Statistical Techniques for CS/BIT 2021-1B

Practice test #2

Time: 2hrs 15min

Instructions. This test consists of 6 exercises. The formula sheet and the probability tables are provided. An ordinary calculator is allowed, not a programmable one (GR).

If a question asks "is there a statistical test that . . . ", this should be interpreted as "a statistical test *covered in this course* that . . . ".

1. Suppose that the profitability (in %) of a random sample of 51 companies in a specific economic sector was determined and the following numerical summaries are given:

(1) The 5-number-summary is -0.3, 2.1, 2.8, 4.1, 7.5

(2) The classical numerical summary is (the Standard Error of a statistic is indicated with "± SE")

Size	Mean	Stand. Dev.	Variance	Skewness	Kurtosis
51	3.0	1.40	1.96	0.51 ± 0.34	2.81 ± 0.48

a. Determine whether there are outliers according to the $1.5 \times$ IQR-rule.

b. Does the classical numerical summary support the assumption of a normal distribution for the profitability of an arbitrary company in the sector? Why (not)?

c. Determine a 95%-confidence interval for the expected profitability of a company in the sector.

d. Is for the interval in c. the normality assumption strictly necessary? Why (not)?

2. Let T_1 , T_2, $...T_n$ be a random sample of size n from a population. Which of the following is a better estimator for the population variance σ^2? Motivate your answer with your arguments.

(a) $1/n \sum_{i=1}^{n}(T_i - \overline{T})^2$

(b) $1/(n-1) \sum_{i=1}^{n}(T_i - \overline{T})^2$

3. Classify each of the following statements about statistical power as either true or false.

(a) Power is the ability of a test to identify an effect given that an effect of a certain size exists in a population.

(b) Power is associated to the probability of making a Type II error.

(c) The power of a test is the probability that a given test is reliable and valid.

(d) Power can be used to determine the sample size required to detect an effect of a certain size.

(e) The power of a statistical test depends on the sample size and whether the test is a one- or two-tailed test.

4. A test of $H_0 : \mu = 0$ versus $H_1 : \mu < 0$ is conducted on the same population independently by two separate researchers. They use the same sample size n=100 and also the same value of $\alpha = 0.01$ for different samples from the same population. Which of the following is true? (Check all that apply).

(a) Both researchers have the same observed test statistic.

(b) Both researchers have the same decision whether or not to reject the null hypothesis.

(c) If the true $\mu = -10$ then both researches will have the same power.

(d) Both researchers will have the same p value.

(e) Both researchers will test the same assumptions.

5. Do the corona measures affect the student achievement at university level? The programme management of a study programme compared the results (number of completed EC's in a year) of two random samples of first year students, in 2018-2019 (pre-corona) and 2019-2020 (corona). Researchers are interested if the variances for the EC-numbers in the mentioned two years do not differ significantly (with a significance level of 1 %). Below are the relevant results:

	n	Mean	Std. Dev.
2018-2019	13	51.2	7.1
2019-2020	15	48.1	11.4

	Shapiro Wilk	
	Statistic	df
2018-2019	0.795	12
2019-2020	0.927	14

(a) Which test can be applied to test the equality of variances? Write down the assumptions needed to check the equality of variances.

(b) Check whether the assumptions you have stated hold. Justify your answers.

6. To test the new design, a group of 8 top athletes were invited for two races: one with the old design shoes and one with the new design shoes. A 3-day-rest between the 2 races was taken into account. The racers used the old design shoes in the first race and then the new design shoes in the latter race after 3 days. The results (times in seconds) are as follows:

Athlete	1	2	3	4	5	6	7	8
Old design shoe	45.38	44.98	46.12	45.52	46.03	44.87	45.66	46.25
New design shoe	45.12	45.05	45.87	45.25	45.91	44.61	45.16	45.98

(a) Assume there is enough statistical evidence that the above data follows a normal distribution. Are the racers on average faster on the newly designed shoes (according to the above sample)? Conduct an appropriate parametric test with a significance level $\alpha = 0.05$ to answer this question.

(b) Assume now there is not enough statistical evidence to support the assumption of a normal distribution. Which test can serve as a non-parametric alternative for the test in part a? To answer this question :

i. Define for this test: the test statistic and its observed value,

ii. Give the hypotheses,

iii. Determine the p-value,

iv. Draw your conclusion, in words, as compared with $\alpha = 0.05$

$$\text{Grade} = 1 + \frac{\#\text{ points}}{33} \times 9$$

Rounded to 1 decimal

question	1	2	3	4	5	6	Total
points possible	10	3	3	3	7	7	33