Practice Exam 2

STA 3024 Spring 2023

Class #: 16898 (Zheng)

Name: ______________________________

UFID: ______________________________

Instructions:

1. This examination contains 8 pages, including this page.
2. You have **50 minutes** to complete the exam.
3. The total score is 105. The extra 5 points serve as a buffer, so the highest score you can get is 100.
4. Write your answers clearly and legibly on the exam. Answers without sufficient work shown will not receive full credit.
5. You may use a scientific calculator. Do not share a calculator with anyone.
6. This is a closed-book exam. You may not use any resources including lecture notes, books, or other students.
7. Please sign the below Honor Code statement.

In recognition of the UF Student Honor Code, I certify that I will neither give nor receive unauthorized aid on this examination.

Signature: ______________________________

1. (5 points) Which of the following tests can be a nonparametric alternative to ANOVA for comparing means of three or more independent groups? Circle your choice and write the letter in the blank below.

   A. Pearson χ^2 test

   B. Wilcoxon rank-sum test (Mann-Whitney test)

   C. Wilcoxon signed rank test

   D. Signed test for the population median

   E. Kruskal-Wallis H-test

1. ____________

2. (30 points) Are the following statements true or false? You do not need to give reasons.

   (a) ___ Contingency tables give us a way to study the relationship between two quantitative variables.

   (b) ___ In Pearson χ^2 tests, a large p-value proves that two variables are independent.

   (c) ___ One of the assumptions for contingency table inference is a minimum of 5 expected counts per cell, but in practice, we check for a minimum of 5 observations per cell.

   (d) ___ Suppose a contingency table has degrees of freedom 8. Then as long as we are given the counts in any 8 cells and all of the row and column totals, the table is uniquely determined.

   (e) ___ A contingency table with 7 rows and 4 columns has degrees of freedom 24.

   (f) ___ If a random variable X follows a standard normal distribution, i.e. $\mathcal{N}(0, 1)$, then X^2 follows χ^2 distribution with degree of freedom 1.

   (g) ___ Both parametric and nonparametric methods can only work when there are no outliers.

   (h) ___ Suppose a random variable X follows a Binomial distribution with parameters $n = 10$ and $p = 0.5$. Then $P(X = 3) = \binom{10}{3} \times 0.5^{10}$.

   (i) ___ When doing Wilcoxon signed rank test, we eliminate the pairs that have a response difference of exactly zero.

   (j) ___ Generally speaking, parametric methods are more powerful than nonparametric methods. As a result, with the same data, it is harder for nonparametric methods to gather enough evidence to reject the null hypothesis than for parametric methods.

3. Do plain and peanut m&m's have the same distribution of colors? Several bags of each variety (plain and peanut) were randomly selected, and the number of candies of each color was counted before eating any of them. The data appears below.

	blue	yellow	red	brown	green	orange	TOTAL
plain	81	84	41	17	30	41	294
peanut	17	7	27	13	14	16	94
TOTAL	98	91	68	30	44	57	388

(a) (9 points) Compute the following quantities from the table.

- The probability that a peanut candy is red.
- The probability that an m&m is blue and plain (at the same time).
- The probability that an m&m is green.

(b) (5 points) Compute the residual for the blue/peanut category.

(c) (4 points) State both the null and alternative hypotheses for Pearson χ^2 test.

(d) (5 points) The table below shows some of the expected counts. Complete the table and write down the numbers in the blank below the table. You do not need to show your calculation process.

	blue	yellow	red	brown	green	orange
plain	74.3	69.0	51.5	(i)	33.3	43.2
peanut	(ii)	22.0	16.5	7.3	10.7	13.8

(i)__________ (ii)__________

(e) (3 points) What is the contribution to the test statistic for the orange/peanut category?

(f) (4 points) What conclusions can we reach from the Pearson χ^2 test given the p-value is smaller than 0.001?

4. Is the movie *Avatar: The Way of Water* worse than *Avatar(2009)*? Some professional raters were asked to give ratings to the two movies on a scale of 1-10 with a higher score meaning a better movie. The data is shown below. We will analyze it using the Wilcoxon signed rank test.

rater	The Way of Water	Avatar (2009)
1	10	10
2	1	4
3	10	8
4	7	9
5	2	7
6	6	7
7	4	8
8	9	10

(a) (5 points) Briefly discuss why it is better to conduct the Wilcoxon signed rank test than some normal-based parametric test here.

(b) (5 points) State the null and alternative hypotheses. (If you are using any notation, please clarify the meaning)

(c) (10 points) Compute the test statistic W_+.

(d) (5 points) Suppose the p-value is 0.04462. Based on this p-value, what conclusions can we make?

5. (15 points) An intranasal monoclonal antibody (HNK20) was tested against the respiratory syncytial virus (RSV) in rhesus monkeys (Weltsin, et al.,1996). A sample of $N = 24$ monkeys was given RSV, and randomly assigned to receive one of 4 treatments: placebo, 0.2 mg/day, 0.5 mg/day, or 2.5 mg/day HNK20. The monkeys, free of RSV, received the treatment intranasally once daily for two days, then were given RSV and given treatment daily for four more days. Nasal swabs were collected daily to measure the amount of RSV for 14 days. The table below gives the peak RSV titer (log10/mL) for the 24 monkeys by treatment and their corresponding ranks (in parentheses), as well as the rank sum W_i for each group. Note that low RSV titers correspond to more effective treatment. We can use the Kruskal–Wallis H-test to determine whether or not treatment differences exist.

Placebo	HNK20 (0.2mg/day)	HNK20 (0.5mg/day)	HNK20 (2.5mg/day)
5.5 (19)	3.5 (9)	4.0 (11.5)	2.5 (6)
6.0 (22.5)	5.5 (19)	3.0 (7.5)	≤ 0.5 (2.5)
4.5 (14.5)	6.0 (22.5)	4.0 (11.5)	≤ 0.5 (2.5)
5.5 (19)	4.0 (11.5)	3.0 (7.5)	1.5 (5)
5.0 (16.5)	6.0 (22.5)	4.5 (14.5)	≤ 0.5 (2.5)
6.0 (22.5)	5.0 (16.5)	4.0 (11.5)	≤ 0.5 (2.5)
$W_1 = 114$	$W_2 = 101$	$W_3 = 64$	$W_4 = 21$

The formulae for computing the K-W test statistic are

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{g} n_i(\bar{R}_i - \bar{R})^2$$

$$D = 1 - \frac{\sum(t^3 - t)}{(N-1)N(N+1)}$$

For convenience, the ordered ranks are listed below:

$$2.5, 2.5, 2.5, 2.5, 5, 6, 7.5, 7.5, 9, 11.5, 11.5, 11.5, 11.5,$$

$$14.5, 14.5, 16.5, 16.5, 19, 19, 19, 22.5, 22.5, 22.5, 22.5.$$

Please find the Kruskal-Wallis test statistic. (If you do not have enough space to write down your answer below, feel free to use the next page)

(Problem 5 continued)