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Laboratory Section: 2 – BSDS Date: 11/20/2024

Objectives:

At the end of this exercise, you should be able to:

1. Check the assumptions of the Kruskal Wallis and Friedman tests.

2. Perform the Kruskal Wallis and Friedman tests.

3. Perform nonparametric post-hoc analysis.

Materials

1. Statistical software (Excel, PAST, R) Total: 60 pts

Activity For every item, do the following.

a. Provide a summary of the assumptions tests with complete evidences/justifications. Remember that we should perform a parametric test whenever possible. So, start this portion with a justification why a parametric test is not applicable, i.e. show how you can't meet one parametric assumption. Only one is needed. Then, proceed with meeting all other assumptions required to make valid conclusions from the test you are planning to use for that item. **(10pts)**

b. Provide a summary of the hypothesis test, including the Post-Hoc test if necessary. This portion includes the hypotheses, decision rule, computations, decision, and conclusion. Show your solution if the computation was done manually. Otherwise, attach screenshot of results from statistical software used. Provide a summary table to summarize the post-hoc analysis if performed. **(20pts)**

Problem 1

A certain collector is choosing between 4 different paintings to buy. To help him decide, he asked 10 randomly selected subjects to rate the 4 different paintings on a scale from 0 (don't like it at all) to 5 (like it very much). The following table shows the data for all subjects and paintings. Is there a painting that is more preferred? Test at the 5% level of significance.

	Painting 1	Painting 2	Painting 3	Painting 4
1	0	5	1	4
2	3	4	2	5
3	1	4	3	4
4	2	2	2	3
5	2	3	4	3
6	0	3	1	5
7	3	5	3	4
8	2	3	1	5
9	1	5	2	4
10	2	4	0	3

a.) In this problem, a parametric test cannot be applied despite satisfying the assumptions of normality and homoscedasticity. This is because the data is ordinal, as the paintings were rated on a fixed scale from 0 to 5.

Kruskal Wallis Assumption:

1. The test uses ordinal data, as the paintings are rated on a fixed scale from 0 to 5.

2. Each observation is independent of all other observations.

a. Kruskal Wallis

Experimental Unit: 4 different painting

Factor of Interest: Painting

Treatment Levels: Painting 1, 2, 3, 4

Blocking: None (CRD has no blocking factors)

Response Variable: preferred painting (rating)

Hypotheses:

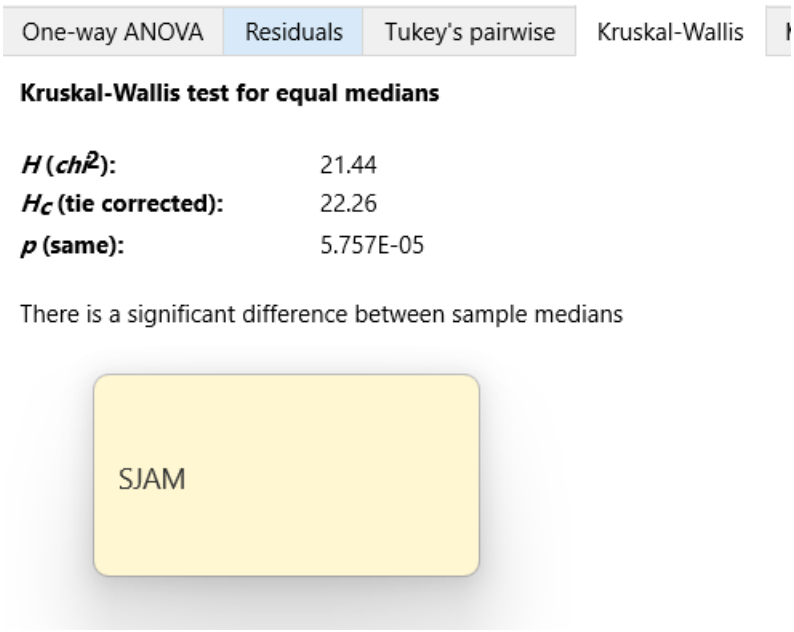
H_0: The 5 paintings are equally preferred.

H_a: At least one painting is prefer.

Decision Rule

Reject H_0 if p-value < a (0.05). Otherwise, fail to reject H_0.

Computation:



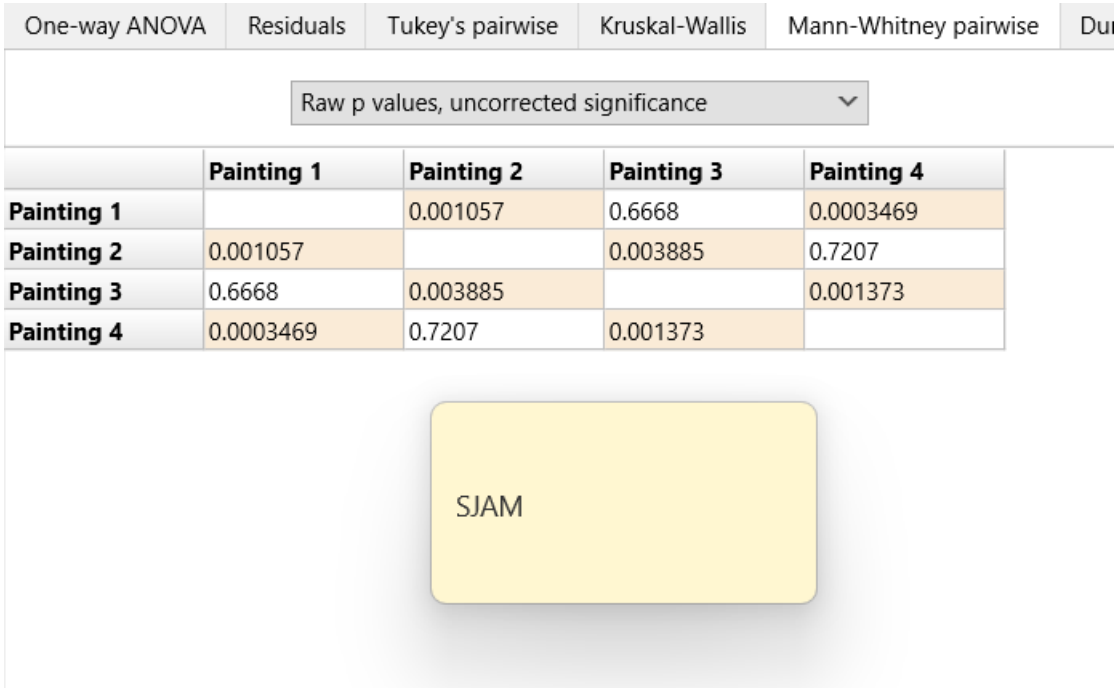
Decision:

Rejecting H_0 because the p-value (**0.00005757**) is less than 0.05.

Conclusion:

The Kruskal-Wallis test revealed that at least one painting is significantly more preferred than the others at the 5% significance level. As a result, a post-hoc analysis was performed to determine which paintings showed significant differences in preference. This follow-up analysis allows for a clearer understanding of which specific paintings are favored.

Post- hoc analysis:



	Painting 1	Painting 2	Painting 3	Painting 4
Painting 1		0.001057	0.6668	0.0003469
Painting 2	0.001057		0.003885	0.7207
Painting 3	0.6668	0.003885		0.001373
Painting 4	0.0003469	0.7207	0.001373	

M_1 vs M_2: 0.001057

M_1 vs M_4: 0.0003469

M_2 vs M_3: 0.003885

M_3 vs M_4: 0.001373

Medians to be Compared	**Stepwise Bonferroni corrected p-values from Mann-Whitney pairwise tests**	**Decision**	**Conclusion**
Md_1 vs Md_4	p-value: 0.0003469 x 6 = 0.0020814	Since 0.0020814 < 0.05, reject H_o	Statistically different medians
Md_1 vs Md_2	p-value: 0.001057 x 5 = 0.005285	Since 0.005285 < 0.05, reject H_o	Statistically different medians
Md_3 vs Md_4	p-value: 0.001373 x 4 = 0.005492	Since 0.005492 < 0.05, reject H_o	Statistically different medians
Md_2 vs Md_3	p-value: 0.003885 x 3 = 0.011655	Since 0.011655 < 0.05, reject H_o	Statistically different medians

Md_1 vs Md_3	p-value: 0.6668 x 2 = 1.3336	Since 1.3336 > 0.05, fail to reject Ho	Not statistically different medians

The procedure will be discontinued, and it will be concluded that the remaining pairwise comparisons, M2 vs. M4 and Md3 vs. Md1, do not show statistical significance.

Summary of the stepwise Bonferroni corrected p-values from Mann-Whitney pairwise test results

Painting	**Median**
1	2^a
2	4^b
3	2^a
4	4^b

Means sharing the same letter are not significantly different.

Conclusion:

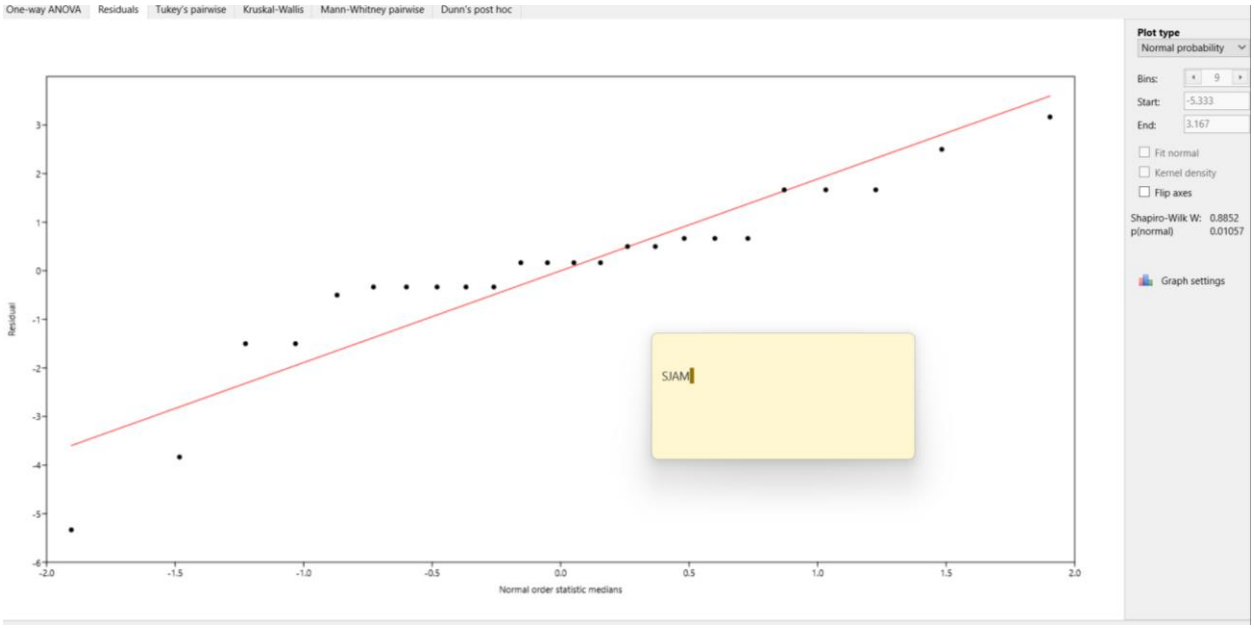
The subjects gave similar ratings to paintings A and C, as well as to paintings B and D. Their preferences were divided into two groups. Since the medians of paintings B and D are higher than those of paintings A and C, it appears that the subjects favored paintings B and D.

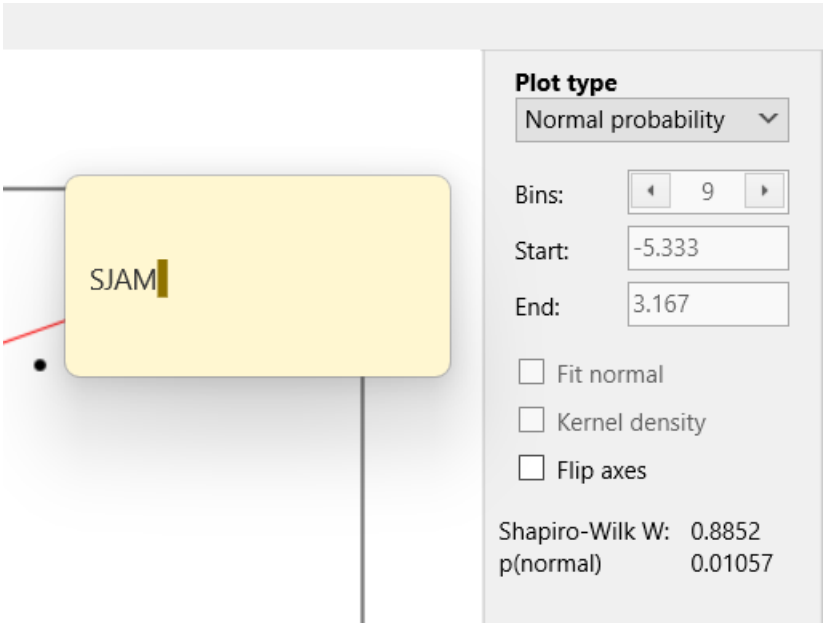
Problem 2

An important issue in conservation biology is how dispersal among populations influences the persistence of species in a fragmented landscape. Molofsky and Ferdy (2005) measured this in the annual plant, Cardamine pensylvanica, a weed that produces explosively dispersed seeds. Four treatments were used to manipulate seed dispersal by changing the distance among experimental plant populations. These treatments were adjacent (continuous treatment), separated by 23.2 cm (medium), separated by 49.5 cm (long), or separated by partitions that blocked all seed dispersal among populations (isolated). Treatments were randomly assigned to plant populations. The data shown are the number of generations that the populations persisted in six replicates of each treatment. Test whether the persistence of species differ with distance among experimental plant populations at 5% significance level. Conduct a follow up analysis when necessary.

Isolated	Medium	Long	Continuous
9	14	13	9
8	9	9	13
8	16	10	13
8	16	11	16
8	16	11	13
9	15	9	13

Normality Test:





The normality assumption is not met since the p-normal (0.01057) < 0.05 and the plot does not follow a diagonal line.

a. In this case, applying the Friedman test is the best option since the normality assumption was not met, as previously indicated. Additionally, the ratio of the highest variance to the lowest variance exceeds 3.

Assumption #1: Each treatment was applied to all blocks.
Assumption #2: The variable is at least on an ordinal scale.
Assumption #3: The pairs of observations are independent of each other.

b. Friedman Test

c.

Experimental Unit: Plant Population

Factor of Interest: Seed Dispersal Distance

Treatment Levels: Dispersal Conditions: Isolated, Medium, Long, Continuous

Blocking: Environmental Factors

Response Variable: Generation Persistence

Hypotheses:

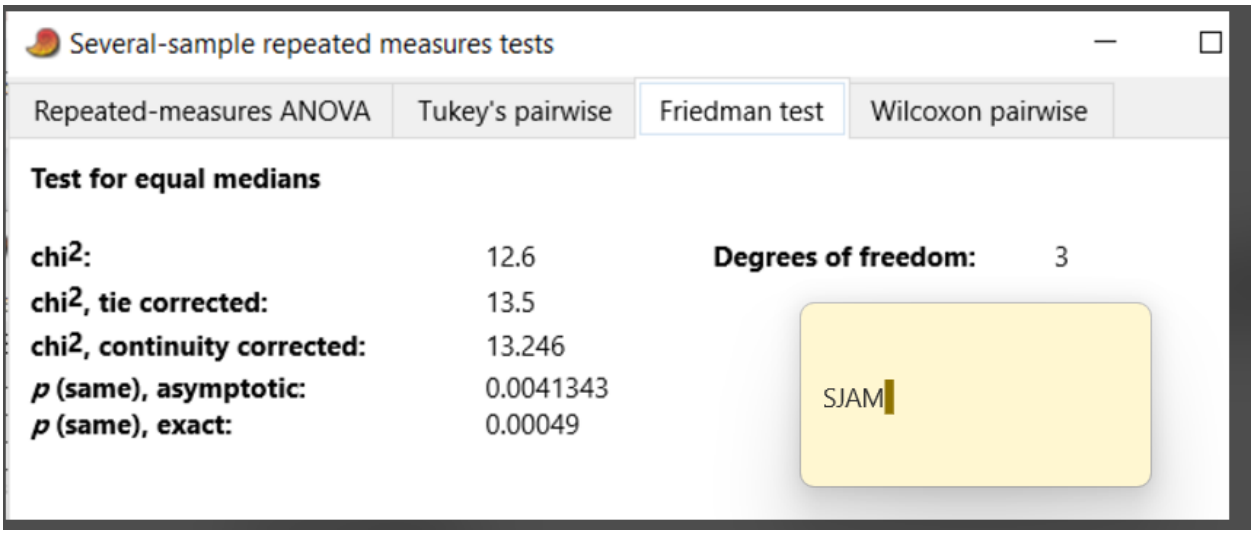
H0: Generation persistence is consistent across all dispersal conditions in the plant population.

Ha: At least one dispersal distance condition shows a significant difference in generation persistence.

Decision Rule

Rejecting the H_0 if p-value is less than (0.05). Otherwise, fail to reject H_0.

Computation:

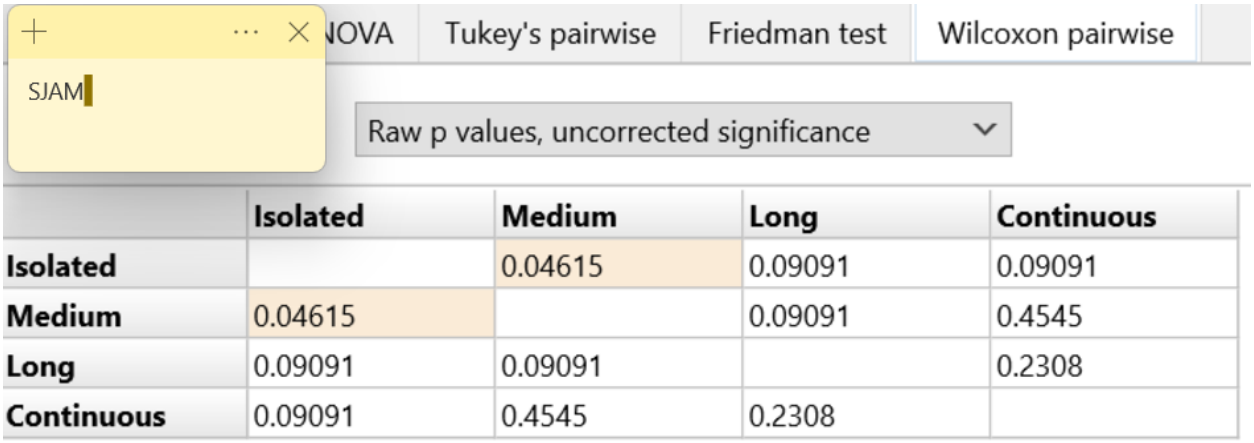


Decision:

p-value (0.00049) is less than 0.05, we will reject H_o.

Conclusion:

The Friedman test results indicated that at least one dispersal distance condition shows a significant difference in generation persistence at the 5% significance level. Given the significant result, a post-hoc analysis is conducted. This further analysis will help identify which specific dispersal conditions contribute to the differences in generation persistence.



	Isolated	Medium	Long	Continuous
Isolated		0.04615	0.09091	0.09091
Medium	0.04615		0.09091	0.4545
Long	0.09091	0.09091		0.2308
Continuous	0.09091	0.4545	0.2308	

Condition	Median
Isolated	8[a]
Medium	15.5[b]
Long	10.5[a]
Continuous	13[a]