

CHAPTER 18—NONPARAMETRIC METHODS

MULTIPLE CHOICE

1. A collection of statistical methods that generally requires very few, if any, assumptions about the population distribution is known as
- parametric methods
 - nonparametric methods
 - distribution-fixed methods
 - normal

ANS: B

PTS: 1

TOP: Nonparametric Methods

2. The collection of statistical methods that require assumptions about the population is known as
- distribution free methods
 - nonparametric methods
 - small populations
 - parametric methods

ANS: D

PTS: 1

TOP: Nonparametric Methods

3. Parametric methods are statistical methods that
- require some assumptions about the population
 - require no assumptions about the population
 - only deal with small samples
 - considers the sign of two matched samples

ANS: A

PTS: 1

TOP: Nonparametric Methods

4. Which of the following tests would not be an example of a nonparametric method?
- Mann-Whitney-Wilcoxon test
 - Wilcoxon signed-rank test
 - sign test
 - t-test

ANS: D

PTS: 1

TOP: Nonparametric Methods

5. A sign test is a
- parametric method for determining the differences between two populations based on two matched samples
 - nonparametric method for determining the differences between two populations based on two matched samples
 - nonparametric method for determining the differences between two or more populations based on two or more matched samples
 - parametric method for determining the differences between two or more populations based on two or more matched samples

ANS: B

PTS: 1

TOP: Nonparametric Methods

6. The level of measurement that allows for the rank ordering of data items is
- nominal measurement
 - ratio measurement
 - interval measurement
 - ordinal measurement

ANS: D PTS: 1 TOP: Nonparametric Methods

7. The level of measurement that is simply a label for the purpose of identifying an item is
- ordinal measurement
 - ratio measurement
 - nominal measurement
 - interval measurement

ANS: C PTS: 1 TOP: Nonparametric Methods

8. The labeling of parts as "defective" or "non-defective" is an example of
- ordinal data
 - ratio data
 - interval data
 - nominal data

ANS: D PTS: 1 TOP: Nonparametric Methods

9. In a questionnaire, respondents are asked to mark their marital status. Marital status is an example of the
- ordinal scale
 - nominal scale
 - ratio scale
 - interval scale

ANS: B PTS: 1 TOP: Nonparametric Methods

10. The scale of measurement that is used to rank order the observation for a variable is called the
- ratio scale
 - ordinal scale
 - nominal scale
 - interval scale

ANS: B PTS: 1 TOP: Nonparametric Methods

11. On a teacher evaluation form students are asked to rate their professor's performance as excellent, very good, good, and poor. This is an example of the
- ordinal scale
 - ratio scale
 - nominal scale
 - interval scale

ANS: A PTS: 1 TOP: Nonparametric Methods

12. Temperature is an example of a variable that uses
- the ratio scale
 - the interval scale
 - the ordinal scale
 - either the ratio or the ordinal scale

ANS: B PTS: 1 TOP: Nonparametric Methods

13. The speed of an automobile is an example of a variable that uses the
- ratio scale
 - interval scale

- c. nominal scale
- d. ordinal scale

ANS: A PTS: 1 TOP: Nonparametric Methods

14. Statistical methods that generally require very few, if any, assumptions about the population distribution are known as
- a. parametric
 - b. nonparametric
 - c. free methods
 - d. None of these alternatives is correct.

ANS: B PTS: 1 TOP: Nonparametric Methods

15. Which of the following tests would not be an example of nonparametric method?
- a. Mann-Whitney-Wilcoxon test
 - b. Wilcoxon signed-rank test
 - c. sign test
 - d. t test

ANS: D PTS: 1 TOP: Nonparametric Methods

16. A nonparametric version of the Parametric analysis of variance test is the
- a. Kruskal-Wallis Test
 - b. Mann-Whitney-Wilcoxon Test
 - c. sign test
 - d. Wilcoxon Signed-rank test

ANS: A PTS: 1 TOP: Nonparametric Methods

17. A nonparametric method for determining the differences between two populations based on two matched samples where only preference data is required is the
- a. Mann-Whitney-Wilcoxon test
 - b. Wilcoxon signed-rank test
 - c. sign test
 - d. Kruskal-Wallis Test

ANS: C PTS: 1 TOP: Nonparametric Methods

18. When ranking combined data in a Wilcoxon signed rank test, the data that receives a rank of 1 is the
- a. lowest value
 - b. highest value
 - c. middle value
 - d. average of the highest and the lowest of values

ANS: A PTS: 1 TOP: Nonparametric Methods

19. Statistical methods that require assumptions about the population are known as
- a. distribution free
 - b. nonparametric
 - c. either distribution free or nonparametric
 - d. parametric

ANS: D PTS: 1 TOP: Nonparametric Methods

20. The Spearman rank-correlation coefficient is

- a. a correlation measure based on the average of data items
- b. a correlation measure based on rank-ordered data for two variables
- c. a correlation measure based on the median of data items
- d. None of these alternatives is correct.

ANS: B PTS: 1 TOP: Nonparametric Methods

21. A nonparametric test for the equivalence of two populations would be used instead of a parametric test for the equivalence of the population parameters if
- a. the samples are very large
 - b. the samples are not independent
 - c. no information about the populations is available
 - d. The parametric test is always used in this situation.

ANS: C PTS: 1 TOP: Nonparametric Methods

22. A nonparametric test would be used if
- a. nominal data is available
 - b. interval data is available
 - c. it is known that the population is normally distributed
 - d. None of these alternatives is correct.

ANS: A PTS: 1 TOP: Nonparametric Methods

23. If a null hypothesis that states that two populations are identical is rejected using a nonparametric test, then it is safe to assume that
- a. neither the means nor the variances are equal
 - b. the means of the populations are not the same
 - c. the variances of the populations are not the same
 - d. We cannot be sure of the way in which the populations differ from each other.

ANS: D PTS: 1 TOP: Nonparametric Methods

24. The Spearman rank-correlation coefficient for 20 pairs of data when $\sum d_i^2 = 50$ is.
- a. 0.0063
 - b. 0.0376
 - c. 0.9624
 - d. 0.9937

ANS: C PTS: 1 TOP: Nonparametric Methods

Exhibit 19-1

Fifteen people were given two types of cereal, Brand X and Brand Y. Two people preferred Brand X and thirteen people preferred Brand Y. We want to determine whether or not customers prefer one brand over the other.

25. Refer to Exhibit 19-1. The null hypothesis that is being tested is
- a. $H_0: \mu = 5$
 - b. $H_0: \mu = 0.5$
 - c. $H_0: P = 5$
 - d. $H_0: P = 0.5$

ANS: D PTS: 1 TOP: Nonparametric Methods

26. Refer to Exhibit 19-1. To test the null hypothesis, the appropriate probability distribution to use is
- a. normal

- b. chi-square
- c. Poisson
- d. binomial

ANS: D PTS: 1 TOP: Nonparametric Methods

27. Refer to Exhibit 19-1. The p -value for this test is
- a. 0.0005
 - b. 0.001
 - c. 0.0037
 - d. 0.0074

ANS: D PTS: 1 TOP: Nonparametric Methods

28. Refer to Exhibit 19-1. At 95% confidence, the null hypothesis should
- a. be rejected
 - b. not be rejected
 - c. be revised
 - d. None of these alternatives is correct.

ANS: A PTS: 1 TOP: Nonparametric Methods

Exhibit 19-2

Students in statistics classes were asked whether they preferred a 10-minute break or to get out of class 10 minutes early. In a sample of 150 students, 40 preferred a 10-minute break, 80 preferred to get out 10 minutes early, and 30 had no preference. We want to determine if there is a difference in students' preferences.

29. Refer to Exhibit 19-2. The null hypothesis that is being tested is
- a. $H_0: \mu = 5$
 - b. $H_0: \mu = 0.5$
 - c. $H_0: P = 5$
 - d. $H_0: P = 0.5$

ANS: D PTS: 1 TOP: Nonparametric Methods

30. Refer to Exhibit 19-2. The mean and the standard deviation of the sampling distribution of the number of students who preferred to get out early are
- a. 50 and 30
 - b. 60 and 30
 - c. 50 and 5.478
 - d. 60 and 5.478

ANS: D PTS: 1 TOP: Nonparametric Methods

31. Refer to Exhibit 19-2. To test the null hypothesis, the appropriate probability distribution to use is the
- a. normal
 - b. chi-square
 - c. t distribution
 - d. binomial

ANS: A PTS: 1 TOP: Nonparametric Methods

32. Refer to Exhibit 19-2. The test statistic based on the number of students who preferred to get out early equals
- a. 1.825

- b. 0.67
- c. 0.82
- d. 3.65

ANS: D PTS: 1 TOP: Nonparametric Methods

33. Refer to Exhibit 19-2. The p -value for testing the hypotheses is
- a. less than 0.002
 - b. between 0.002 and 0.05
 - c. between 0.05 and 0.10
 - d. greater than 0.10

ANS: A PTS: 1 TOP: Nonparametric Methods

34. Refer to Exhibit 19-2. The null hypothesis should be
- a. rejected
 - b. not rejected
 - c. revised
 - d. None of these alternatives is correct.

ANS: A PTS: 1 TOP: Nonparametric Methods

Exhibit 19-3

It is believed that the median yearly income in a suburb of Atlanta is \$70,000. A sample of 67 residents was taken. Thirty-eight had yearly incomes above \$70,000, 26 had yearly incomes below \$70,000, and 3 had yearly incomes equal to \$70,000. The null hypothesis to be tested is H_0 : median = \$70,000.

35. Refer to Exhibit 19-3. To test the null hypothesis, the appropriate probability distribution to use is
- a. normal
 - b. chi-square
 - c. t distribution
 - d. binomial

ANS: A PTS: 1 TOP: Nonparametric Methods

36. Refer to Exhibit 19-3. The mean and the standard deviation (respectively) for this test about the median are
- a. 32 and 4
 - b. 32 and 16
 - c. 33.5 and 4
 - d. 33.5 and 16

ANS: A PTS: 1 TOP: Nonparametric Methods

37. Refer to Exhibit 19-3. The test statistic has a value of
- a. 1.00
 - b. 1.50
 - c. 2.00
 - d. 2.50

ANS: B PTS: 1 TOP: Nonparametric Methods

38. Refer to Exhibit 19-3. The p -value for this test is
- a. 0.4332
 - b. 0.8664

- c. 0.0668
- d. 0.1336

ANS: D PTS: 1 TOP: Nonparametric Methods

39. Refer to Exhibit 19-3. The null hypothesis should be
- a. rejected
 - b. not rejected
 - c. revised
 - d. None of these alternatives is correct.

ANS: B PTS: 1 TOP: Nonparametric Methods

Exhibit 19-4

A company advertises that food preparation time can be significantly reduced with the Handy Dandy Slicer. A sample of 12 individuals prepared the ingredients for a meal with and without the slicer. You are given the preparation times below.

Person	Preparation Times	
	With Slicer	Without Slicer
1	20	22
2	12	18
3	20	18
4	14	22
5	19	19
6	20	21
7	19	18
8	15	12
9	22	18
10	19	25
11	21	26
12	23	20

40. Refer to Exhibit 19-4. To test the null hypothesis, the appropriate probability distribution to use is
- a. normal
 - b. chi-square
 - c. t distribution
 - d. binomial

ANS: A PTS: 1 TOP: Nonparametric Methods

41. Refer to Exhibit 19-4. The test statistic equals
- a. -0.81 or 0.81
 - b. -0.89 or 0.89
 - c. -10 or 10
 - d. -20 or 20

ANS: B PTS: 1 TOP: Nonparametric Methods

42. Refer to Exhibit 19-4. The *p*-value for this test is
- a. 0.3133
 - b. 0.6266
 - c. 0.3734
 - d. 0.8167

ANS: B PTS: 1 TOP: Nonparametric Methods

43. Refer to Exhibit 19-4. The null hypothesis should
- be rejected
 - not be rejected
 - be revised
 - None of these alternatives is correct.

ANS: B PTS: 1 TOP: Nonparametric Methods

Exhibit 19-5

It has been hypothesized that there is no difference in the mathematical ability of men and women. To test this hypothesis, it was decided to use the Mann-Whitney-Wilcoxon test. A sample of men and women were given math tests. The scores on the tests are given below.

Women		Men	
Person	Score	Person	Score
1	95	1	80
2	86	2	87
3	100	3	93
4	100	4	95
5	99	5	97
6	98	6	82
7	88	7	89
8	92	8	86
9	94	9	75
10	89	10	82
		11	79

44. Refer to Exhibit 19-5. To test the null hypothesis, the appropriate probability distribution to use is
- normal
 - chi-square
 - t distribution
 - binomial

ANS: A PTS: 1 TOP: Nonparametric Methods

45. Refer to Exhibit 19-5. The mean (μ_T) is
- 10
 - 110
 - 66
 - 55

ANS: D PTS: 1 TOP: Nonparametric Methods

46. Refer to Exhibit 19-5. The standard deviation (σ_T) is
- 10
 - 11.5
 - 14.2
 - 110

ANS: C PTS: 1 TOP: Nonparametric Methods

Exhibit 19-6

Forty-one individuals from a sample of 60 indicated they oppose legalized abortion. We are interested in determining whether or not there is a significant difference between the proportions of opponents and proponents of legalized abortion.

47. Refer to Exhibit 19-6. The null hypothesis that is being tested is

- a. $H_0: \mu = 5$
- b. $H_0: \mu = 0.5$
- c. $H_0: P = 5$
- d. $H_0: P = 0.5$

ANS: D PTS: 1 TOP: Nonparametric Methods

48. Refer to Exhibit 19-6. μ in this situation is

- a. 60
- b. 30
- c. 41
- d. 2

ANS: B PTS: 1 TOP: Nonparametric Methods

49. Refer to Exhibit 19-6. σ in this problem is

- a. 15
- b. 5.47
- c. 3.87
- d. 7.45

ANS: C PTS: 1 TOP: Nonparametric Methods

50. Refer to Exhibit 19-6. The test statistics is

- a. 3.87
- b. 2.84
- c. 60
- d. 0.5

ANS: B PTS: 1 TOP: Nonparametric Methods

51. Refer to Exhibit 19-6. p -value is

- a. 0.0023
- b. 0.0046
- c. 0.4954
- d. 0.4977

ANS: B PTS: 1 TOP: Nonparametric Methods

52. Refer to Exhibit 19-6. The null hypothesis should be

- a. rejected
- b. not rejected
- c. Not enough information is given to answer this question.
- d. None of these alternatives.

ANS: A PTS: 1 TOP: Nonparametric Methods

53. Refer to Exhibit 19-6. The conclusion is that there

- a. is no significant difference between the proportions
- b. is a significant difference between the proportions
- c. could be a difference in proportions, depending on the sample size

d. None of these alternatives is correct.

ANS: B

PTS: 1

TOP: Nonparametric Methods

PROBLEM

1. In a sample of 400 people, 250 indicated that they prefer domestic wines, while 140 said they prefer European wines, and 10 indicated no preference. We want to use the sign test to determine if there is evidence of a significant difference in the preferences for the two types of wine.
 - a. Provide the hypotheses to be tested.
 - b. Compute the mean.
 - c. Compute the standard deviation.
 - d. At 95% confidence, test to determine if there is evidence of a significant difference in the preferences for the two types of wine.

ANS:

a. $H_0: P = 0.5$

$H_a: P \neq 0.5$

b. 195

c. 9.874

d. Test Statistic $Z = 5.57$; $p\text{-value} < 0.05$, therefore reject H_0 ($p\text{-value}$ is almost zero)

PTS: 1

TOP: Nonparametric Methods

2. In a sample of 200 racquetball players, 120 indicated they prefer Penn racquetballs, 75 favored Ektelon, and 5 were indifferent. We want to use the sign test to determine if there is evidence of a significant difference in the preferences for the two types of racquetballs.
 - a. Provide the hypotheses to be tested.
 - b. Compute the mean.
 - c. Compute the standard deviation.
 - d. At 95% confidence, test to determine if there is evidence of a significant difference in the preferences for the two types of racquetballs.

ANS:

a. $H_0: P = 0.5$

$H_a: P \neq 0.5$

b. 97.5

c. 6.982

d. Test Statistic $Z = 3.22$; $p\text{-value} < 0.05$, therefore reject H_0 ($p\text{-value}$, using Excel = 0.00127)

PTS: 1

TOP: Nonparametric Methods

3. The monthly sales records of two branches of a department store (Branch A and Branch B) over the last year (12 months) were gathered. It was decided to use the Mann-Whitney-Wilcoxon test to determine if there has been a significant difference between the sales of the two branches.
 - a. Provide the hypotheses for this test.
 - b. Compute the mean μ_T .
 - c. Compute the standard deviation σ_T .
 - d. The sum of the ranks for branch A was determined to be 184.5. Compute the test statistic Z .
 - e. Use $\alpha = 0.05$ and test to determine if there is a significant difference in the populations of the

sales of the two branches.

ANS:

- a. H_0 : The two populations are identical.
 H_a : The two populations are not identical.
- b. 150
- c. 17.32
- d. 1.99
- e. $p\text{-value} < \alpha = 0.05$, the null hypothesis is rejected (actual $p\text{-value}$ using Excel =0.046).

PTS: 1

TOP: Nonparametric Methods

4. Independent random samples of the scores of 10 daily quizzes from day students and 15 quizzes from evening students were gathered. It was decided to use the Mann-Whitney-Wilcoxon test to determine if there is a significant difference between the scores of the two groups of students.
 - a. Provide the hypotheses for this test.
 - b. Compute the mean μ_T .
 - c. Compute the standard deviation σ_T .
 - d. The sum of the ranks for the day students was determined to be 184.5. Compute the test statistic Z .
 - e. Use $\alpha = 0.05$ and test to determine if there is a significant difference in the populations of the scores of the two groups.

ANS:

- a. H_0 : The two populations are identical.
 H_a : The two populations are not identical.
- b. 195
- c. 18.0277
- d. 2.05
- e. $p\text{-value} < \alpha = 0.05$, the null hypothesis is rejected (actual $p\text{-value}$ using Excel =0.0401).

PTS: 1

TOP: Nonparametric Methods

5. The sales records of two branches of a department store over the last 12 months are shown below. (Sales figures are in thousands of dollars.) We want to use the Mann-Whitney-Wilcoxon test to determine if there is a significant difference in the sales of the two branches.

Month	Branch A	Branch B
1	257	210
2	280	230
3	200	250
4	250	260
5	284	275
6	295	300
7	297	320
8	265	290
9	330	310
10	350	325
11	340	329
12	272	335

- a. Compute the sum of the ranks (T) for branch A.

- b. Compute the mean μ_T .
- c. Compute σ_T .
- d.. Use $\alpha = 0.05$ and test to determine if there is a significant difference in the populations of the sales of the two branches.

ANS:

- a. 148.5
- b. 150
- c. 17.32
- d.. $Z = -0.08$; p -value = 0.9362; do not reject H_0 ; distributions are identical

PTS: 1 TOP: Nonparametric Methods

6. Independent random samples of ten day students and ten evening students at a university showed the following age distributions. We want to use the Mann-Whitney-Wilcoxon test to determine if there is a significant difference in the age distribution of the two groups.

Day	Evening
26	32
18	24
25	23
27	30
19	40
30	41
34	42
21	39
33	45
31	35

- a. Compute the sum of the ranks (T) for the day students.
- b. Compute the mean μ_T .
- c. Compute σ_T .
- d.. Use $\alpha = 0.05$ and test for any significant differences in the age distribution of the two populations.

ANS:

- a. 74.5
- b. 105
- c. 13.23
- d.. p -value < .05; reject H_0 ; the populations are different (the actual p -value using Excel is .0211)

PTS: 1 TOP: Nonparametric Methods

7. From the courthouse records, it is found that in 60 divorce cases, the filing for divorce was initiated by the wife 41 times. Using the sign test, test for a difference in filing between husband and wives. Let $\alpha = 0.05$

ANS:

$Z = 2.84$; p -value = 0.0046; reject H_0 and conclude there is a significant difference.

PTS: 1 TOP: Nonparametric Methods

8. Two employers (A and B) ranked five candidates for a new position. Their rankings of the candidates are shown below.

Candidate	Rank by A	Rank by B
Nancy	2	1
Mary	1	3
John	3	4
Lynda	5	5
Steve	4	2

Compute the Spearman rank-correlation and test it for significance. Let $\alpha = 0.05$.

ANS:

Spearman rank-correlation = 0.5; $Z = 1.0$; p -value = 0.3174; do not reject H_0

PTS: 1 TOP: Nonparametric Methods

9. The following data show the test scores of six individuals on a standardized test before and after attending a preparation seminar for the test.

Person	Before	After
A	108	110
B	102	118
C	107	105
D	97	97
E	112	116
F	108	106

Use the Wilcoxon Signed-Rank test in order to determine whether or nor the seminar has been effective. Hint: This is a one tailed test. Let $\alpha = 0.05$.

ANS:

$Z = -0.94$; p -value = 0.1736; do not reject H_0

PTS: 1 TOP: Nonparametric Methods

10. Fifteen people were asked to indicate their preference for domestic versus imported cars. The following data showed their preferences.

Individual	Domestic vs. Imported
1	+
2	+
3	-
4	+
5	+
6	+
7	-
8	+
9	+
10	+
11	+
12	+
13	+

14	+
15	-

With $\alpha = 0.05$, test for a significant difference in the preferences for cars. A "+" indicates a preference for imported cars.

ANS:

p -value = 0.0352; reject H_0 ; there is a preference for imported cars

PTS: 1

TOP: Nonparametric Methods

11. The following data show the preference of 20 people for a candidate to a public office. A "+" indicates a preference for the Democratic candidate, and a "-" indicates a preference for the Republican candidate.

Individual	Republicans vs. Democrats
1	+
2	-
3	+
4	+
5	+
6	+
7	-
8	+
9	+
10	+
11	+
12	-
13	-
14	+
15	+
16	-
17	-
18	+
19	+
20	+

With $\alpha = 0.05$, test for a significant difference in the preference for the candidates.

ANS:

p -value = 0.1154; do not reject H_0 ; there is no significant difference

PTS: 1

TOP: Nonparametric Methods

12. In a sample of 120 people, 50 indicated that they prefer domestic automobiles, 60 said they prefer foreign-made cars, and 10 indicated no difference in their preference. At a 0.05 level of significance, determine if there is evidence of a significant difference in the preferences for the two makes of automobiles.

ANS:

$Z = -0.95$; p -value = 0.3422; do not reject H_0 ; no evidence of preference

PTS: 1 TOP: Nonparametric Methods

13. In a sample of 300 shoppers, 160 indicated they prefer fluoride toothpaste, 120 favored nonfluoride, and 20 were indifferent. At a 0.05 level of significance, test for a difference in the preference for the two kinds of toothpaste.

ANS:

Mean = 140

Standard Deviation = 8.367

$Z = 2.39$; p -value = 0.0168; reject H_0 ; there is a significant difference

PTS: 1 TOP: Nonparametric Methods

14. Test scores of ten individuals before and after a training program are shown below.

Individual	Score Before the Program	Score After the Program
1	59	57
2	57	62
3	60	60
4	66	63
5	68	69
6	59	63
7	72	74
8	52	56
9	58	64
10	63	64

At $\alpha = 0.05$, what can be concluded about the effectiveness of the training program?

ANS:

$Z = -1.66$; p -value = 0.097; do not reject H_0 ; populations are identical

PTS: 1 TOP: Nonparametric Methods

15. Ten drivers were asked to drive two models of a car. Each car was given one gallon of gasoline. The distance that each automobile traveled on a gallon of gasoline is shown below.

Driver	Distance Traveled (Miles)	
	Model A	Model B
1	27.7	27.1
2	28.4	28.0
3	28.9	28.7
4	27.9	27.6
5	26.5	26.0
6	29.1	29.0
7	28.9	28.2
8	28.9	28.0
9	28.8	28.0
10	28.0	27.0

At $\alpha = 0.05$, what can be concluded about the performance of the two models?

ANS:

$T = 55$

Standard Deviation = 19.62

$Z = 2.8$; p -value = 0.0052; reject H_0

PTS: 1

TOP: Nonparametric Methods

16. A PTA group wishes to determine whether a barrage of letters sent to the local station has reduced the amount of violence broadcast between the hours of 4 P.M. and 9 P.M. The results of a survey of viewers are given here.

Response	Number of Respondents
More Violence	4
Less Violence	11
No Change	6

Carry out a sign test to determine whether or not the letters were effective in reducing the amount of violence during the 4 to 9 p.m. period. Use a .05 level of significance. Be sure to state the null and alternative hypotheses.

ANS:

$H_0: p = 0.5$

$H_a: p \neq 0.5$

p -value = 0.1186; do not reject the null hypothesis

PTS: 1

TOP: Nonparametric Methods

17. A clothing manufacturer purchased some newly designed sewing machines in the hopes that production would be increased. The production records of a random sample of workers are shown below.

Worker	Old Machine	New Machine
1	28	36
2	36	40
3	27	25
4	25	32
5	38	30
6	36	32
7	40	40
8	29	28
9	32	35
10	28	33
11	20	26
12	32	31
13	32	23
14	32	34
15	36	36

Use the Wilcoxon signed-rank test to determine whether the new machines have significantly increased production. Use a .05 level of significance.

ANS:

$Z = -0.56$ (rounded); p -value = 0.2123 (one tailed); do not reject the null hypothesis

PTS: 1

TOP: Nonparametric Methods

18. The president of a company wants to see if the new anti-smoking campaign is having any influence on his employees. A sample of 100 employees who smoked prior to the campaign is taken. Thirty-six employees said they smoked less, 15 employees said they smoked more, and 49 employees said there was no change.
- State the null and alternative hypotheses.
 - Test the null hypothesis at the 1% level of significance.

ANS:

- $H_0: p = 0.5$
 $H_a: p \neq 0.5$
- $Z = 2.94$; p -value = 0.0032; reject the null hypothesis

PTS: 1

TOP: Nonparametric Methods

19. It is believed that the median age of college students is 21 years. A sample of 80 college students is taken. Thirty of the students were under 21, 45 of the students were over 21, and 10 were 21 years old.
- State the null and alternative hypotheses.
 - Test the null hypothesis at the 1% level of significance.

ANS:

- $H_0: \text{Median} = 21$
 $H_a: \text{Median} \neq 21$
- $Z = 1.73$; p -value = 0.0836; do not reject the null hypothesis

PTS: 1

TOP: Nonparametric Methods

20. We want to see if the workers on the day and night shifts differ significantly in their productivity levels. A sample of workers from both shifts was taken.

Day Shift		Night Shift	
Worker	Output	Worker	Output
1	31	1	31
2	32	2	25
3	26	3	29
4	34	4	30
5	24	5	27
6	35	6	33
7	39	7	37
8	28	8	39
9	44	9	38
10	42	10	36
		11	40

- a. State the null and alternative hypotheses.
- b. Test the null hypothesis at the 5% level of significance.

ANS:

- a. H_0 : The two populations are identical
 H_a : The two populations are not identical
- b. $Z = 0.07$; p -value = 0.9442; do not reject the null hypothesis

PTS: 1 TOP: Nonparametric Methods

21. The manager of a company believes that differences in sales performance depends upon the salesperson's age. Independent samples of salespeople were taken and their weekly sales record is reported below.

Below 30 Years	Between 30 & 45 Years	Over 45 Years
No. of Sales	No. of Sales	No. of Sales
24	23	30
16	17	20
21	22	23
15	25	25
19	18	34
26	29	36
	27	28

- a. State the null and alternative hypotheses.
- b. At 95% confidence, test the hypotheses.

ANS:

- a. H_0 : All three populations are identical
 H_a : Not all populations are identical
- b. $W = 6.78$; p -value is between .025 and .05; reject H_0 (critical $\chi^2 = 5.991$)

PTS: 1 TOP: Nonparametric Methods

22. Two faculty members ranked 12 candidates for scholarships. Calculate the Spearman rank-correlation coefficient and test it for significance. Use a .02 level of significance.

Candidate	Rank by Professor A	Rank by Professor B
1	6	5
2	10	11
3	2	6
4	1	3
5	5	4
6	11	12
7	4	2
8	3	1
9	7	7
10	12	10
11	9	8
12	8	9

ANS:

$$r_s = 0.8671$$

$Z = 2.88$; p -value = 0.004; reject the null hypothesis; the rank correlation is significant

PTS: 1

TOP: Nonparametric Methods

23. A comprehensive statistics examination is given to 16 students in order to determine whether or not there is a significant difference in the performance of students majoring in the various disciplines of Business Administration. The following data show the scores of the 16 students (5 majoring in accounting, 6 majoring in management, and 5 majoring in marketing).

Accounting	Management	Marketing
91	63	95
80	92	80
70	86	70
60	75	60
85	70	90
	99	

At $\alpha = 0.05$ level of significance, test to see if there is a significant difference in the performance of the students in the three majors.

ANS:

$W = 0.36$; p -value > 0.1; no significant difference (critical $\chi^2 = 5.991$)

PTS: 1

TOP: Nonparametric Methods

24. A survey of male and female students showed the following ranking of 12 professors in the management department:

Professor	Ranking By Female Students	Ranking By Male Students
1	7	8
2	8	7
3	1	2
4	2	3
5	9	1
6	3	10
7	10	9
8	11	4
9	4	6
10	6	11
11	12	5
12	5	12

Do the rankings given by the female students agree with the rankings given by the male students? Use $\alpha = 0.05$.

ANS:

$r_s = -0.028$; $Z = -0.09$; p -value = 0.9282; do not reject H_0 ; no significant rank correlation

PTS: 1

TOP: Nonparametric Methods

25. Two individuals were asked to rank the performances of eight different automobiles. The following show their rankings.

Automobile	Ranking by First Person	Ranking by Second Person
1	3	2
2	5	1
3	1	4
4	6	7
5	2	5
6	4	8
7	7	6
8	8	3

Determine the Spearman rank-correlation coefficient; and at 95% confidence, test for its significance.

ANS:

$$r_s = 0.0714$$

$Z = 0.19$; p -value = 0.8494; do not reject H_0 ; no significant rank correlation

PTS: 1 TOP: Nonparametric Methods

26. Two groups of students were asked to rank the activities sponsored by the Student Government Association on campus. The following show their rankings.

Activity	Resident Student Ranking	Nonresident Student Ranking
1	3	6
2	1	2
3	8	5
4	2	1
5	5	7
6	7	8
7	4	3
8	6	4

Determine the Spearman rank-correlation coefficient and test for a significant correlation with $\alpha = 0.05$.

ANS:

$$r_s = 0.64$$

$Z = 1.69$; p -value = 0.091; do not reject H_0 ; no significant rank correlation

PTS: 1 TOP: Nonparametric Methods

27. Two faculty members (X and Y) ranked five candidates for scholarships. The rankings are shown below.

Candidate	Rank By X	Rank By Y
Peter	5	1
Nancy	2	2

Michael	1	3
Mary	3	5
Judy	4	4

Compute the Spearman rank-correlation and test it for significance. Let $\alpha = 0.05$.

ANS:

$$r_s = -0.2$$

$Z = 0.53$; p -value = 0.5964; do not reject H_0 ; no significant rank correlation

PTS: 1

TOP: Nonparametric Methods

28. Three universities in your state have decided to administer the same comprehensive examination to the recipients of MBA degrees. From each institution, a random sample of MBA recipients has been selected and given the test. The following table shows the scores of the students from each university.

Northern University	Central University	Southern University
56	62	94
85	97	72
65	91	93
86	82	78
93		54
		77

Use the Kruskal-Wallis test to determine if there is a significant difference in the average scores of the students from the three universities. Let $\alpha = 0.01$.

ANS:

$W = 0.2$; p -value > 0.1 ; do not reject H_0 ; no significant difference (critical $\chi^2 = 9.210$)

PTS: 1

TOP: Nonparametric Methods