

NON-PARAMETRIC INFERENCE

1. A manufacturer of electric bulbs claims that he has developed a new production process which will increase the average efficiency (in suitable units) from the present value of 9.03. The results obtained from an experiment with 15 bulbs from the new process are given as follows :

9.29	10.15	8.69
11.25	11.47	9.76
12.05	12.38	9.08
10.25	8.93	9.02
10.87	10.00	11.56

Do we have reasons to believe that the efficiency has increased ?

2. 20 ear-head measurements of a variety of wheat are given as follows :

9.3	8.8	10.7	11.5
8.2	9.7	10.3	8.6
11.3	10.7	11.2	9.0
9.8	9.3	9.9	10.3
10.0	10.1	9.6	10.4

Test at 5% level of significance whether the population median length of ear-head is 9.9 cm. by using Wilcoxon signed-rank test.

3. The following are the marks secured by two batches of salesmen in the final test taken after completion of training. Use an appropriate non-parametric test with $\alpha = 0.02$ for the null hypothesis that the samples are drawn from identical distributions against the alternative that the distributions differ in location only.

Batch *A* : 26, 27, 31, 26, 19, 21, 20, 25, 30;

Batch *B* : 23, 28, 26, 24, 22, 19.

4. Given below are the marks obtained by a group of 20 students in a subject in a college test and in the subsequent public examination. Test at 1% level whether the group has improved its average performance from the college test to the public examination, by using
- (i) the sign test
 - (ii) the Wilcoxon signed-rank test

Serial No.	Marks Obtained in	
	College Test	Public Examination
1	183	133
2	175	193
3	134	170
4	170	164
5	183	199
6	167	160
7	120	168
8	175	158
9	126	162
10	187	176
11	123	126
12	121	141
13	175	103
14	133	126
15	144	146
16	109	155
17	165	162
18	144	161
19	164	182
20	125	119

5. Scores on a clerical aptitude test administered to a batch of 6 Secretariat and 7 Directorate clerks are given below. Test whether the two groups of clerks have the same score distribution in the population.

Scores of Secretariat clerks	40	35	52	60	46	55	
Scores of Directorate clerks	47	56	42	57	50	57	62

6. Consider two samples as follows :

$$\mathbf{X} = (1, 5, 7, 9, 15, 17, 21, 23)$$

$$\mathbf{Y} = (2, 6, 10, 12, 18, 20, 26, 28, 32).$$

Test whether they have homogenous population distribution.

7. Ten points are taken in an interval of length one meter. The distance of each point from the start of the interval is (in meters) as follows :

$$\begin{array}{cccccc} 0.414 & 0.523 & 0.229 & 0.942 & 0.097 & \\ 0.394 & 0.572 & 0.486 & 0.273 & 0.358 & \end{array}$$

Test whether the sample can be considered as a sample from $U(0, 1)$ distribution.

8. The following is a random sample of size 20. Test whether the sample can be considered as a sample from $N(0, 1)$ distribution.

$$\begin{array}{cccccc} 2.240 & -0.400 & -1.152 & 0.980 & 0.361 & \\ -0.123 & -0.625 & 0.682 & 2.323 & -1.053 & \\ -0.870 & -0.164 & -0.340 & -0.041 & 1.405 & \\ 1.187 & 0.323 & 0.270 & -0.128 & 0.101 & \end{array}$$

9. Thirty observations as given below are obtained :

$$\begin{array}{l} 24, 35, 12, 50, 60, 70, 68, 49, 80, 25, 69, 28, 28, 11, 83, \\ 31, 37, 34, 54, 75, 45, 95, 75, 26, 43, 57, 94, 48, 63, 45 \end{array}$$

Test their randomness by considering the sequence of positive and negative signs.

10. Fifteen 3-year-old boys and fifteen 3-year-old girls were observed during two sessions of recess in a nursery school. Each child's play was scored for incidence and degree of aggression as follows:

Boys: 96 65 74 78 82 121 68 79 111 48 53 92 81 31 40
 Girls: 12 47 32 59 83 14 32 15 17 82 21 34 9 15 51

Is there evidence to suggest that there are sex differences in the incidence and amount of aggression? Use both Mann–Whitney and run tests.

11. Some depressed people were found, and it was checked that initially they were all equivalently depressed. Then each person was allocated randomly to one of three groups: no exercise; 20 minutes of jogging per day; or 60 minutes of jogging per day. At the end of a month, each participant was asked to rate how depressed they now feel on a Likert scale that runs from 1 (totally miserable) through to 100 (ecstatically happy).

Rating on depression scale:

	No Exercise	Jogging for 20 minutes	Jogging for 60 minutes
	23	22	59
	26	27	66
	51	39	38
	49	29	49
	58	46	56
	37	48	60
	29	49	56
	44	65	62
Mean →	39.63	40.63	55.75
SD →	12.85	14.23	8.73

- (a) Does physical exercise alleviate depression?
 (b) Is there a difference in the ratings of the participants allocated to no exercise group as compared to those allocated to 20 minutes of jogging group?

12. A medical researcher wishes to determine if a pill has the undesirable side effect of reducing the blood pressure of the user. The study involves recording the blood pressures of 15 women. After they use the pill regularly for six months, their blood pressures are again recorded. The observations are given in the following table.

Subject	Before	After
1	70	68
2	80	72
3	72	62
4	76	70
5	76	58
6	76	66
7	72	68
8	78	52
9	82	64
10	64	72
11	74	74
12	92	60
13	74	74
14	68	72
15	84	74

Carry out a suitable non-parametric test to determine if blood pressure has decreased after taking the pill.