

Non-parametric Tests 1

Q1.

- (a) State briefly the circumstances under which a non-parametric test of significance should be used rather than a parametric test. [1]

The level of pollution in a river was measured at 12 randomly chosen locations. The results, in suitable units, are shown below, where higher values represent greater pollution.

5.62 5.73 6.55 6.81 6.10 5.75 5.87 6.47 5.86 6.26 6.99 5.91

- (b) Use a Wilcoxon signed-rank test to test whether the average pollution level in the river is more than 6.00. Use a 5% significance level. [6]

Q2.

The times, in milliseconds, taken by a computer to perform a certain task were recorded on 10 randomly chosen occasions. The times were as follows.

6.44 6.16 5.62 5.82 6.51 6.62 6.19 6.42 6.34 6.28

It is claimed that the median time to complete the task is 6.4 milliseconds.

- (a) Carry out a Wilcoxon signed-rank test at the 5% significance level to test this claim. [6]
 (b) State an underlying assumption that is made when using a Wilcoxon signed-rank test. [1]

Q3.

A biologist is studying the effect of nutrients on the heights to which plants grow. A random sample of 24 similar young plants is divided into two equal groups *A* and *B*. The plants in group *A* are fed with nutrients and water and the plants in group *B* are given only water. After four weeks, the height, in cm, of each plant is measured and the results are as follows.

Group <i>A</i>	12.3	11.8	12.1	13.2	11.1	10.6	13.8	12.0	12.2	12.4	13.5	13.9
Group <i>B</i>	11.7	10.8	10.9	11.3	11.2	12.6	11.0	10.5	11.9	12.5	10.7	11.6

The biologist decides to carry out a test at the 5% significance level to test whether the nutrients have resulted in an increase in growth.

- (a) She carries out a Wilcoxon rank-sum test. Give a reason why this is an appropriate choice of test. [1]
 (b) Carry out the Wilcoxon rank-sum test for these results. [10]

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Q4.

Metal rods produced by a certain factory are claimed to have a median breaking strength of 200 tonnes. For a random sample of 9 rods, the breaking strengths, measured in tonnes, were as follows.

210 186 188 208 184 191 215 198 196

A scientist believes that the median breaking strength of metal rods produced by this factory is less than 200 tonnes.

- (a) Use a Wilcoxon signed-rank test, at the 5% significance level, to test whether there is evidence to support the scientist's belief. [6]
- (b) Give a reason why a Wilcoxon signed-rank test is preferable to a sign test, when both are valid. [1]

Q5.

A large school is holding an essay competition and each student has submitted an essay. To ensure fairness, each essay is given a mark out of 100 by two different judges. The marks awarded to the essays submitted by a random sample of 12 students are shown in the following table.

Student	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>	<i>G</i>	<i>H</i>	<i>I</i>	<i>J</i>	<i>K</i>	<i>L</i>
Judge 1	62	74	52	48	68	55	56	64	37	70	81	59
Judge 2	65	70	47	49	76	74	67	54	50	77	72	75

- (a) One of the students claims that Judge 2 is awarding higher marks than Judge 1.

Carry out a Wilcoxon matched-pairs signed-rank test at the 5% significance level to test whether the data supports the student's claim. [7]

It is discovered later that the marks awarded to student *A* have been entered incorrectly. In fact, Judge 1 awarded 65 marks and Judge 2 awarded 62 marks.

- (b) By considering how this change affects the test statistic, explain why the conclusion of the test carried out in part (a) remains the same. [2]