



QUESTION WORKBOOK

Non-parametric tests

Further Statistics 2 · Year FM

15 questions · 67 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up**A1**

NP-A1

State what makes a hypothesis test non-parametric, and give one situation in which you would prefer such a test to a t-test.

[2]

A2

NP-A2

A supplier claims the median mass of its bags of compost is 25 kg. Eleven bags are weighed and nine of them exceed 25 kg, with none equal to it. Carry out a sign test at the 5% level of the claim against the alternative that the median mass exceeds 25 kg.

[3]

A3

NP-A3

State the null hypothesis of a sign test, and explain why the number of readings above the claimed value follows a binomial distribution with $p = \frac{1}{2}$ when that hypothesis is true.

[2]

A4

NP-A4

Eight readings are 14.2, 11.9, 15.6, 12.9, 13.4, 16.1, 10.7 and 14.9, and a claimed median is 13.0. Write down the deviations from 13.0, rank their sizes, and find the two signed-rank totals T_+ and T_- .

[3]

SECTION B · Standard**B1**

NP-B1

Name the non-parametric test you would use in each case, with a reason. (a) The house prices of 9 properties sold in one town and 9 sold in another are compared for a difference in level. (b) Twelve judges each taste two wines and say which of the two they prefer. (c) A single sample of 15 reaction times, from a population known to be skewed, is tested against a claimed median. [3]

B2

NP-B2

A machine is claimed to fill tubs to a median of 50 g. Nine tubs contain 52.4, 49.3, 55.3, 47.9, 53.8, 49.2, 51.5, 56.4 and 55.1 g. Use a Wilcoxon signed-rank test at the 5% level to test the claim against the alternative that the median exceeds 50 g. The critical value is 8. [6]

B3

NP-B3

Ten operators are timed on a task before and after their workstation is rearranged. The numbers of units produced before are 42, 55, 38, 61, 47, 50, 44, 58, 36, 53, and afterwards 56, 52, 60, 68, 45, 61, 62, 53, 62, 62. State whether the samples are paired or independent, and test at the 5% level whether output has risen, using a Wilcoxon matched-pairs signed-rank test. The critical value is 10. [6]

B4

NP-B4

Twelve tasters each try two brands of coffee and record which of the two they prefer, with no taster allowed to record a tie. Nine prefer brand A. Test at the 5% level, in two tails, whether tasters as a population have a preference between the brands. [4]

B5

NP-B5

Seven pairs of twins each attempt a puzzle, one twin of each pair given a hint and the other not. The times taken, in seconds, with hint minus without hint, are -12, -5, -18, +3, -9, -21 and -7. State whether the samples are paired or independent, name the test that uses the sizes of the differences, and test at the 5% level, in one tail, whether the hint reduces the time. The critical value is 3. [5]

B6

NP-B6

Five plants of variety P have heights 34, 41, 28, 39 and 47 cm. Six independent plants of variety Q have heights 52, 44, 38, 57, 49 and 55 cm. Test at the 5% level, in two tails, whether the two varieties have the same distribution of heights. The critical values are 18 and 42. [5]

B7

NP-B7

Name the non-parametric test that fits each of the following, with a reason. (a) A single sample of 20 waiting times is to be tested against a claimed median, but only whether each time was above or below the claim has been recorded. (b) Twelve students sit a test before and after a course, and both marks are recorded for each student. (c) Measurements from two independent processes, 7 from one and 11 from the other, are compared. [3]

SECTION C · Stretch**C1**

NP-C1

Six plots given fertiliser A yield 12, 15, 18, 23, 26 and 37 kg; eight independent plots given fertiliser B yield 21, 29, 31, 34, 40, 43, 46 and 52 kg. Test at the 5% level, in two tails, whether the two fertilisers give the same distribution of yields. The critical values are 29 and 61. [7]

C2
NP-C2

Twenty-five paired differences are ranked by size and the negative ranks total 95. The table of critical values does not extend to $n = 25$. Use a normal approximation, with a continuity correction, to test at the 5% level in one tail whether the median difference is positive. State also what difference the continuity correction makes here. [6]

C3
NP-C3

Two independent samples, of sizes 15 and 18, are compared with a Wilcoxon rank-sum test, and the rank total for the sample of 15 is 200. The tables of critical values do not reach these sample sizes. Use a normal approximation, with a continuity correction, to test at the 5% level, in two tails, whether the two populations are identical. [6]

C4

NP-C4

Two independent samples, of sizes 7 and 9, are compared with a Wilcoxon rank-sum test, and the rank total for the sample of 7 is $W = 42$. Write down the smallest and the largest values W could take. The lower critical value for a two-tailed test at the 5% level is 40; find the upper one and carry out the test. The Mann-Whitney statistic is $U = W - \frac{1}{2}m(m + 1)$, where m is the smaller sample size; find U and state what it counts. [6]

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