### JAN 2012

The gross annual salaries for medical specialists working in the EU during 2003 were investigated.

The median gross annual salary for medical specialists working in the UK during 2003 was found to be £81 050.

The gross annual salary, converted into £, for each of 9 randomly selected medical specialists working in France during 2003 was recorded as follows.

69 100 63 520 64 600 72 000 58 450 82 200 66 500 86 600 68 200

- Carry out a Wilcoxon signed-rank test, using the 5% significance level, to investigate (a) whether, during 2003, the average gross annual salary for medical specialists working in the UK was greater than that for those working in France. (8 marks)
- (b) State one assumption that is necessary for the test in part (a) to be valid. (1 mark)

### JAN 2013

**JUNE 2013** 

A chef decides to investigate whether the taste of food is influenced by the sounds heard whilst eating it. She selects 8 regular customers at her restaurant and asks them if they would each be willing to eat a free seafood dish on two separate occasions and score each dish on a scale of 0 to 20 for taste.

The seafood dishes are identical, but the background sounds played through the restaurant's speakers differ on the two occasions. Seaside sounds are played on one of the occasions when the seafood dish is eaten, but the usual background music is played on the other occasion when the seafood dish is eaten.

The scores are given in the table.

	Customer								
	A	В	C	D	E	F	G	Н	
Score with seaside sounds playing	17	15	14	9	16	19	11	10	
Score with usual background music playing	13	9	12	12	17	16	6	3	

Carry out a Wilcoxon signed-rank test, using the 5% significance level, to investigate whether, on average, the taste score for the seafood dish is higher when the seaside sounds are played than when the usual background music is played. (8 marks)

### JUNE 2012

and Test B.

Dexter's
(2 marks)

**(e)** <u>a</u>

 $\equiv$ 

(c) (ii)

9 €

 $\equiv$ 

a)

Test A;

Test B.

State the assumption, regarding the distribution test in part (c)(i) to be valid. Carry out a Wilcoxon whether there is any o Find the value of the product the two tests. difference in

of scores,

ō

scores for (3 marks)

(3 marks)

With reference to your findings in parts (a), (b) and (c)(i), compare Test A and Test B. (3 marks) Dexter, the Head of Recruitment for the combined skills test was too long for ap

Calculate values

for the mean and the standard deviation of the scores

applicants be

Test B Test A These scores, as percentages,

to nine applicants. For each are totalled to give a score those tasks originally from [ given in the ₽.

Each test comprises 10 di test will be combined in a 20 tasks. 10 different tasks, d in a random ord it is deci produce

Two different skills tests, Test A and Test B, are used regularly to suitability of applicants for employment as machine operators at a company. The company's director wishes to compare Test A and ' to evaluate the a large engineering I Test B.

As part of an investigation into trends in local authority spending in England, one of the categories of expenditure considered was 'Highways'.

For a random sample of 10 local authorities, the percentages of their total expenditure on 'Highways' during 2002 and also during 2012 are shown in the table.

		Local authority									
		A	В	C	D	E	F	G	Н	I	J
Year	2002	5.6	8.4	8.7	9.3	9.9	9.4	7.9	8.1	9.6	8.6
	2012	8.9	8.4	7.9	8.4	10.2	10.1	8.3	9.8	9.5	9.7

- Carry out a Wilcoxon signed-rank test to investigate whether there was a change in the average percentage of local authority total expenditure on 'Highways' between 2002 and 2012. Use the 5% level of significance.
- (b) (i) State the assumption necessary regarding the distribution of differences in percentage expenditures in order for the test in part (a) to be valid.
  - (ii) Suggest an alternative test that could be used for the investigation in part (a) if the assumption in part (b)(i) was known to be invalid. (2 marks)
- For a Wilcoxon signed-rank test carried out on 10 matched pairs, find:
  - the minimum value possible for the test statistic T;
- (ii) the maximum value possible for the test statistic T.

(3 marks)

# 

PAIRED SAMPLE WILCOXNON SIGN TEST									
Variables:									
H <sub>0</sub> :									
Tailed Test	% Sig Level Difference Rankings								
T*: T-:	_ Test Statistic:								
Critical Value:									
Compare: Conclude: Hence we:									
Therefore there is:									

### **DEFINITIONS**

This examines the

S D

between each reading and the suggested

P A

Rank order values are then assigned to the

D

and, for a two-tailed test, the S

of the totals T<sup>+</sup> or T<sup>-</sup> is the test statistic to be compared with the critical value

If the differences are equal we must find the

A R

and give it to both differences

# The Wilcoxon Signed Rank Test

**Revision Mat** 

# PAIRED SAMPLES

The Paired Sample Wilcoxon Signed-Rank Test is carried out in exactly the same way as the Wilcoxon Signed-Rank test but the difference

B

T

P

is used to rank rather than the difference between

## SIGN OR WILCOXON?

the value and the suggested average

The Wilcoxon signed rank test is a more

A \_\_\_\_ \_ version of the sign test.

We would always choose Wilcoxon over sign where possible.

The data must be assumed to be

S \_\_\_\_\_ about the median for the Wilcoxon to be appropriate

If the data is Q \_\_\_\_\_ we can only use a sign test

### ASSIGNING A RANKED SIGN FOR A ONE SAMPLE TEST

When assigning a ranked sign to the variable we must compare it to the hypotheses. If the value agrees with the alternative hypothesis then we assign a '+' and if not we assign a '-' and rank from 1-n.

For each of the following data sets, assign each value a 'R+' or 'R-' value for its corresponding hypotheses

H <sub>0</sub> : popu										
						3.8	3.5	4.2	4.5	3.7
Rank <sup>-</sup>										
$H_0: \eta = 7$	74cm									
H <sub>1</sub> : η ≠ 7	74 cm									
	72	76	74	70	71	73	75	78	75	76
Rank⁺										
Rank⁻										

# ASSIGNING A RANKED SIGN FOR A PAIRED SAMPLE TEST

When assigning a ranked sign to the pair of variables we must compare the difference of the two values to the hypotheses. If the difference agrees with the alternative hypothesis then we assign a '+' and if not we assign a '-' and rank from 1-n.

For each of the following data sets, assign each value a 'R+' or 'R-' value for its corresponding hypotheses (subtraction order is important!)

<sub>0</sub> : η dif <sub>1</sub> : η dif										
χ	54	57	59	56	53	52	56	58	54	51
Υ	56	59	58	57	54	51	52	53	56	59
diff										
Rank <sup>+</sup>										
Rank⁻										
		n medi n medi			e = 0 e > 0 (a)	A – B)				
Α	9.7	9.4	9.1	9.3	9.6	9.9	9.8	9.7	9.4	9.1
В	9.9	9.8	9.7	9.7	9.8	9.9	9.6	9.5	9.7	9.8
diff Rank <sup>+</sup> Rank <sup>-</sup>			_	_	_	_	_	_	_	