

Essential Mathematics & Statistics for Science: Second Edition by Graham Currell & Antony Dowman (John Wiley & Sons)

Answers to 'Q' Questions

12 Non-Parametric Tests

To navigate, use the Bookmarks in the PDF file.

Refer to Excel (Ch12E.xls) and MINITAB (Ch12M.mpj) files:

Q12.1

MiniTab Session results:

- i) Use Stat > Nonparametrics > 1-Sample Wilcoxon....
Enter Q12.1 as the Variable
Click on Test Median 0.0
Select 'greater than' as the Alternative
OK:----

Wilcoxon Signed Rank Test: Q12.1

Test of median = 0.000000 versus median > 0.000000

	N	N for Test	Wilcoxon Statistic	P	Estimated Median
Q12.1	18	15	92.0	0.037	1.500

$p < 0.05$ so result is Significant.

- ii) Use Stat > Nonparametrics > 1-Sample Wilcoxon....
Enter Q12.1 as the Variable
Click on Test Median 0.0
Select 'not equal' as the Alternative
OK:----

Wilcoxon Signed Rank Test: Q12.1

Test of median = 0.000000 versus median not = 0.000000

	N	N for Test	Wilcoxon Statistic	P	Estimated Median
Q12.1	18	15	92.0	0.074	1.500

$p > 0.05$ so Not Significant

Excel Results:

3	5	-3	5	4	-2	2	4	-1
0	5	0	-4	-2	3	0	1	3

	Abs Vals	Rank		
0	0			
0	0			
0	0			
-1	1	1	1.5	1.5
1	1	2	1.5	
-2	2	3	4	4
2	2	4	4	
-2	2	5	4	4
3	3	6	7.5	
-3	3	7	7.5	7.5
3	3	8	7.5	
3	3	9	7.5	
4	4	10	11	
4	4	11	11	
-4	4	12	11	11
5	5	13	14	
5	5	14	14	
5	5	15	14	
		120	120	28
			W(-) =	28
			W(+) =	92

- i) There are 15 values other than 0 so for 1-tail, $W_L = 30$ from tables. $W(-) < W_L$ so significant
- ii) 15 values 2-tail, $W_L = 25$ so Not Significant

Q12.2

MiniTab Session results:

Use Stat > Nonparametrics > Mann-Whitney....
 Enter Q12.2X as the First Sample
 Enter Q12.2Y as the Second Sample
 Keep Confidence Level as 95
 Select 'not equal' as the Alternative
 OK:---

Mann-Whitney Test and CI: Q12.2X, Q12.2Y

Q12.3X N = 9 Median = 6.900
 Q12.3Y N = 7 Median = 5.600
 Point estimate for ETA1-ETA2 is 1.900
 95.6 Percent CI for ETA1-ETA2 is (0.200,3.801)
 W = 96.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0443

The test is significant at 0.0442 (adjusted for ties)

Excel Results:

X	6.7	5.8	6.9	9.6	8.9	8.2	6.1	4.8	9.2
Y	3.9	6.3	4.4	5.6	6.3	4.2	7.2		

3.9	Y	1	1						
4.2	Y	2	2						
4.4	Y	3	3						
4.8	X	4		4					
5.6	Y	5	5						
5.8	X	6		6					
6.1	X	7		7					
6.3	Y	8.5	8.5						
6.3	Y	8.5	8.5						
6.7	X	10		10					
6.9	X	11		11					
7.2	Y	12	12						
8.2	X	13		13					
8.9	X	14		14					
9.2	X	15		15					
9.6	X	16		16					

40 96

$U_Y = 12$

Mann Whitney U_L for 9 and 7 sample sizes, 2-tails = 12

As $U_Y = 12$ this is significant

Q12.3

MiniTab Session results:

Use Stat > Nonparametrics > 1-Sample Wilcoxon....
 Enter Q12.3 as the Variable
 Click on Test Median 0.0
 Select 'greater than' as the Alternative
 OK:---

Wilcoxon Signed Rank Test: Q12.3

Test of median = 0.000000 versus median not = 0.000000

	N	N for Test	Wilcoxon Statistic	P	Estimated Median
Q12.2	7	7	25.0	0.076	9.000

$p > 0.05$ so Not Significant

Excel Results:

Experts: -	A	B	C	D	E	F	G
Old Whallop, ai	60	59	65	53	86	78	56
Rough Deal, bi	45	62	53	47	65	80	46
Difference, di = ai - bi	15	-3	12	6	21	-2	10
Ranks	6	2	5	3	7	1	4
W+	=6+5+3+7+4 =			25			
W-	=2+1=			3			
W _L				2			

W_L for 7 ranks, 2-tail = 2. $W(-) > W_L$ so Not Significant

Q12.4

MiniTab Session results:

Use Stat > Nonparametrics > Kruskal-Wallis....
 Enter Q12.4 as the Response
 Enter 'Tree' as the Factor
 OK:---

Kruskal-Wallis Test: Q12.4 versus Tree

Kruskal-Wallis Test on Q12.4

Tree	N	Median	Ave Rank	Z
T1	4	3.500	12.8	2.06
T2	4	3.000	10.4	0.91
T3	4	1.500	6.4	-1.03
T4	4	1.500	4.5	-1.94
Overall	16		8.5	

H = 7.43 DF = 3 P = 0.059

H = 7.82 DF = 3 P = 0.050 (adjusted for ties)

* NOTE * One or more small samples

Excel Results:

H = 7.43 and χ^2_{CRIT} (df = 4-1 = 3) = 7.81. Not significant

Q12.5

MiniTab Session results:

Use Stat > Nonparametrics > Friedman....

Enter Q12.4 as the Response

Enter 'Tree' as the Treatment

Enter 'Day' as the Blocks

OK:---

Friedman Test: Q12.4 versus Tree, Day

Friedman test for Q12.4 by Tree blocked by Day

S = 9.53 DF = 3 P = 0.023

S = 10.30 DF = 3 P = 0.016 (adjusted for ties)

Tree	N	Est Median	Sum of Ranks
T1	4	3.750	15.5
T2	4	2.750	12.0
T3	4	1.750	7.0
T4	4	1.250	5.5

Grand median = 2.375

p < 0.05 so Significant

Excel Results:

S = 9.53, $\chi^2_{\text{CRIT}} = 7.81$. Significant

Q12.6

MiniTab Session results:

Use Stat > Nonparametrics > Friedman....

Enter Q12.4 as the Response

Enter 'Day' as the Treatment

Enter 'Tree' as the Blocks

OK:---

Friedman Test: Q12.4 versus Day, Tree

Friedman test for Q12.4 by Day blocked by Tree

S = 7.73 DF = 3 P = 0.052

S = 8.83 DF = 3 P = 0.032 (adjusted for ties)

Day	N	Est Median	Sum of Ranks
D1	4	4.000	15.5
D2	4	2.500	10.0
D3	4	2.000	9.0
D4	4	1.500	5.5

Grand median = 2.500

$p > 0.05$ so Not Significant

Excel Results:

$S = 7.725, \chi^2_{\text{CRIT}} = 7.81.$ Not Significant