Wilcoxon Signed-Ranks Test

Wilcoxon Signed-Ranks Test for Paired Samples

When the requirements for the t-test for two paired samples are not satisfied, the Wilcoxon Signed-Rank Test for Paired Samples non-parametric test can often be used.

In particular, we assume n subjects from a given population with two observations x_i and y_i for each subject i. This results in two paired samples $\{x_1,\ldots,x_n\}$ and $\{y_1,\ldots,y_n\}$ as described in Paired Sample t Test. The requirements for the Wilcoxon Signed-Rank Tests for Paired Samples where $z_i = y_i - x_i$ for all $i = 1, \ldots, n$, are as follows:

- the z_i are independent
- x_i and y_i are interval data (and so a ranking can be applied and differences can be taken)
- The distribution of the z_i is symmetric (or at least not very skewed)

If the second or third assumption is violated, then you should consider using the Sign Test, which doesn't require symmetry.

For this test we use the following null hypothesis:

H_0: the distribution of difference scores in the population is symmetric about zero

I.e. any differences are due to chance. We show how to apply this test via a couple of examples.

Example 1: A researcher wanted to determine whether people's ability to identify objects with their right eye differs from their ability with their left eye. 16 subjects were presented with a series of images and were scored on their abilities to identify objects which each eye. The results are tabulated in Figure 1. Based on this data determine use the Wilcoxon Signed-Ranks Test to whether there is a difference between the two eyes.

	A	B	C	D	E	F	G	H	I	J	K
1	Wilcoxon Signed-Rank Test for Paired Samples										
2											
3	Person	Right	Left	Diff	Abs Diff	Rank of Abs Diff	Positive Ranks	Negative Ranks			
4	1	50	47	3	3	4.5	4.5			α	0.05
5	2	45	45	0						tails	2
6	3	33	31	2	2	2.5	2.5			n	14
7	4	22	24	-2	2	2.5		2.5		T	35.5
8	5	99	78	21	21	14	14			T-crit	21
9	6	79	76	3	3	4.5	4.5			sig	no
10	7	4	13	-9	9	11		11			
11	8	36	46	-10	10	12		12			
12	9	62	45	17	17	13	13				
13	10	51	44	7	7	9	9				
14	11	27	23	4	4	6.5	6.5				
15	12	15	14	1	1	1	1				
16	13	26	34	-8	8	10		10			
17	14	83	79	4	4	6.5	6.5				
18	15	86	81	5	5	8	8				
19	T						69.5	35.5			

Figure 1 – Wilcoxon Signed-Ranks Test for Paired Samples

We perform a two-tailed Wilcoxon Signed-Ranks Test for Paired Samples with $\alpha = .05$ to test the following null hypothesis:

H_o: any differences between the two eyes is due to chance (essentially based on the median of the differences)

The scores for the two eyes are presented in columns B and C. Column D contains the differences between the scores for each subject. Column E contains the absolute value of these differences, eliminating any zero differences from further consideration. Column F contains the adjusted rankings of the non-zero values in column E. Column G reports the values in column F where the difference in column D is positive. Column H reports the values in column F where the difference in column D is negative.

Columns G and H are summed (in cells G19 and H19) to obtain T+ of 69.5 and T- of 35.5. The smaller of these values is the test statistic T = 35.5 (in cell K7).

The critical values for the T statistic are given in the Wilcoxon Signed-Ranks Table. Here we use $\alpha = .05$ and $n = 14$ (i.e. the 15 subjects less the 1 subject where the difference value in column D is zero). From the table we find that $T_{crit} = 21$ (two-tail test). Since $T_{crit} = 21 < 35.5 = T$, we can't reject the null hypothesis (i.e. $p \geq .05$), and so conclude there is no significant difference between the two eyes.

Observation: Generally for $n > 25$, an estimate using the normal distribution can be made (as seen in the next example). The actual threshold of 25 is not universally accepted and can be lowered to around 15 or raised to about 50.

Property 1: When n is sufficiently large, the T statistic (or even T+ or T-) has an approximately normal distribution $N(\mu, \sigma)$ where

$$\mu = \frac{n(n+1)}{4} \qquad \sigma^2 = \frac{n(n+1)(2n+1)}{24}$$

Click here for a proof of Property 1.

Property 2: If there are a large number of ties, a better estimate of the variance is given by

$$\sigma^2 = \frac{n(n+1)(2n+1)}{24} - \frac{1}{48}\sum_t (f_t^3 - f_t)$$

where t varies over the set of tied ranks and f_t is the number of times (i.e. frequency) that the rank t appears.

Observation: It is often desirable to account for the fact that we are approximating a discrete distribution via a continuous one by applying a **continuity correction**. This is done by using a z-score of

$$z = \frac{|U - \mu| - .5}{\sigma}$$

instead of the same formula without the .5 continuity correction factor.

Example 2: A study is made to determine whether there is a difference between husbands and wives attitudes towards politics. A questionnaire measuring this was given to 30 couples with the results summarized in range A3:C33 of Figure 2. Determine whether there is a significant difference between a couple's attitudes towards politics (without using a ties or continuity correction).

	A	B	C	D	E	F	G	H	I	J	K	L	M
3	Couple	Wife	Husband	Diff	Abs Diff	Rank of Abs Diff	Positive Ranks	Negative Ranks					
4	1	15	17	-2	2	6		6		α	0.05		
5	2	8	19	-11	11	26		26		tails	2		
6	3	11	18	-7	7	21.5		21.5		n	28		=COUNT(E4:E33)
7	4	19	19	0						T	90		=MIN(G34:H34)
8	5	13	17	-4	4	13.5		13.5		T-crit	116		table lookup
9	6	4	5	-1	1	2.5		2.5		mean	203		=K6*(K6+1)/4
10	7	16	13	3	3	9.5	9.5			variance	1928.5		=K9*(2*K6+1)/6
11	8	5	0	5	5	16	16			std dev	43.91469		=SQRT(K10)
12	9	9	16	-7	7	21.5		21.5		z-score	2.573171		=ABS(K7-K9)/K11
13	10	15	21	-6	6	18		18		T-crit	116.8788		=K9+K11*NORM.S.INV(K4/2)-0.05
14	11	12	12	0						p-value	0.010077		=2*(1-NORM.S.DIST(K12,TRUE))
15	12	11	9	2	2	6	6			sig	yes		=IF(K14<K4,"yes","no")
16	13	14	10	4	4	13.5	13.5						
17	14	4	17	-13	13	28		28					
18	15	11	12	-1	1	2.5		2.5					
19	16	17	24	-7	7	21.5		21.5					
20	17	14	12	2	2	6	6						
21	18	5	12	-7	7	21.5		21.5					
22	19	9	8	1	1	2.5	2.5						
23	20	8	16	-8	8	24.5		24.5					
24	21	9	12	-3	3	9.5		9.5					
25	22	11	7	4	4	13.5	13.5						
26	23	11	17	-6	6	18		18					
27	24	12	13	-1	1	2.5		2.5					
28	25	17	20	-3	3	9.5		9.5					
29	26	12	9	3	3	9.5	9.5						
30	27	5	13	-8	8	24.5		24.5					
31	28	5	11	-6	6	18		18					
32	29	15	11	4	4	13.5	13.5						
33	30	0	12	-12	12	27		27					
34							90	316					

Figure 2 – Wilcoxon Signed-Ranks Test for Paired Samples

The figure is similar to that in Figure 1. Since T = 90 < 98 = T_{crit} (two-tail test), we conclude there is a significant difference between a husband and his wife's attitude to politics.

Alternatively, we can conduct the analysis using the normal distribution approximation, as we did in Example 2 of Mann-Whitney Test. This time, we calculate a mean of 203 (cell K9), variance of 1928.5 (cell K10) and standard deviation of 43.9 (cell K11). From these we calculate a z-score of 2.57 (cell K12), which yields a p-value (cell K14) of .01 (two-tail test), which is less than α = .05, and so once again we reject the null hypothesis. Note too that T_{crit} = 116.8788 (cell K13), is based on the normal approximation and not a table lookup.

Real Statistics Excel Functions: The following functions are provided in the Real Statistics Pack:

> **SRANK**(R1, R2) = *T* for a pair of samples contained in ranges R1 and R2, where both R1 and R2 have only one column. R1 and R2 must have the same number of elements.
>
> **SRTEST**(R1, R2, *tails, ties, cont*) = p-value for the Signed-Ranks test using the normal distribution approximation for the pair of samples contained in ranges R1 and R2, where both R1 and R2 have only one column. R1 and R2 must have the same number of elements. *tails* = 1 or 2 (default); if *ties* = TRUE (default) then a ties correction is used; if *cont* = TRUE (default) then a continuity correction is used.

There are also versions of SRANK and SRTEST which take only one range R1, which consists of two columns, one for each paired sample.

> **SRANK**(R1) = *T* for a pair of samples contained in range R1, where R1 consists of two columns, one for each paired sample.
>
> **SRTEST**(R1,, *tails, ties, cont*) = p-value for the Signed-Ranks Test using the normal distribution approximation.

These functions ignore any empty or non-numeric cells.

Observation: In Example 2, SRANK(B4:C33) = 90, which is the same as the value shown in cell K7 of Figure 2. The two-tailed p-value (assuming the normal approximation), shown in cell K14, can also be calculated by the formula SRTEST(B4:C33,2,FALSE,FALSE) = 0.010077. We can also use the two argument versions of these functions, namely SRANK(B4:B33,C4:C33) and SRTEST(B4:B33, C4:C33,2,FALSE,FALSE).

Observation: As for the Mann-Whitney test for independent samples, we can use the correlation coefficient *r* as a measure of effect size where

$$r = \frac{z}{\sqrt{2n}}$$

Here $2n$ = the number of observations, including the cases where the difference is 0. For Example 2

$$r = \frac{z}{\sqrt{2n}} = \frac{2.57317}{\sqrt{2 \cdot 30}} = .332$$

which represents a medium-sized effect.

Real Statistics Function: The Real Statistics Pack also provides the following array function for the samples in ranges R1 and R2. The output includes three different estimates of the p-value of the signed-ranks test, namely based on the normal approximation, the exact test and a simulation. The last two of the tests will be described at the end of this webpage.

> **SR_TEST**(R1, R2, *lab, tails, ties, cont, exact, iter*): returns the following values in a 6 × 1 column array: *T*-stat, *z*-stat, *r* effect size and the three types of p-values. If *ties* = TRUE (default), the ties correction is applied. If *cont* = TRUE (default) then the continuity correction is applied. If *lab* = TRUE (default FALSE) then an extra column with labels is included in the output.
>
> If *exact* = TRUE (default FALSE) or if the size of each sample is less than or equal to 500, then the p-value of the exact test is output and if *iter* ≠ 0 then the p-value of the simulation version of the test is output where the simulation consists of *iter* samples (default 10,000).

Once again, the R2 argument can be omitted if R1 contains two columns (one for each sample). The exact and simulation versions of the test are described subsequently.

For Example 2, the array formula =SR_TEST(B4:B33,C4:C33,TRUE,,FALSE,FALSE) returns the array shown in Figure 3:

	Z	AA	AB
14	SR_TEST(no ties or continuity)		
15			
16	T-stat	90	
17	z-stat	2.573171	
18	effect r	0.332195	
19	p-value	0.010077	
20	p-exact	0.00886	
21	p-simul	0.0079	

Figure 3 – Output from SR_TEST for paired samples

Real Statistics Data Analysis Tool: The Real Statistics Resource Pack also provides a data analysis tool which performs the Wilcoxon signed-ranks test for paired samples, automatically calculating the medians, *T* test statistic, z-score, p-values and effect size *r*.

For example, to use this data analysis tool for Example 2, press **Ctrl-m** and choose **T Tests and Non-parametric Equivalents** from the menu that is displayed (or from the **Misc** tab if using the Multipage user interface). A dialog box will appear as shown in Figure 3 in [Mann-Whitney Test for Independent Sample](). Enter B3:C33 in the **Input Range**, check **Column headings included with data**, choose the **Paired samples** and **Non-parametric** options and make sure that all the **Non-parametric test options** are checked.

When you click on the **OK** button the output shown in Figure 4 is displayed.

	T	U	V	W	X
4	Wilcoxon Signed-Rank Test for Paired Samples				
5					
6		Wife	Husband		
7	median	11	12.5		
8					
9	count	30			
10	# unequal	28			
11	T+	90			
12	T-	316			
13	T	90			
14					
15		one tail	two tail		
16	mean	203			
17	std dev	43.87767	ties		
18	z-score	2.563946	yates		
19	effect r	0.331004			
20	p-norm	0.005174	0.010349		
21	p-exact	0.00443	0.00886		
22	p-simul	0.0042	0.0094		

Figure 4 – Wilcoxon signed-ranks data analysis for paired samples

Note that rows 16 through 20 of the figure show the results of the Wilcoxon signed-ranks test using the normal approximation, while the bottom two rows show the p-values of the test using the exact test and simulation respectively.

Since **Use ties correction** is checked, the ties correction defined by Property 2 is applied in the calculation of the standard deviation (cell U17 of Figure 4) as follows.

=SQRT(U16*(2*U10+1)/6)-TiesCorrection(B4:B33,C4:C33,1)/48

where the TiesCorrection function is as described in [Mann-Whitney Test]().

Since the **Use continuity correction** is checked, the 1/2 continuity correction is applied in the calculation of the z-score (cell U18) as follows:

=ABS(ABS(U13-U16)-1/2)/U17

Finally note that the test ignores any data pairs where one or both of the values is non-numeric. The only exception to this is that the median values (U7 and V7 in Figure 4) are calculated separately, and so may include data that is not included in the test (since one of the elements in the pair is non-numeric).

Wilcoxon Signed-Ranks Test for a Single Sample

We can also use the Wilcoxon Signed-Ranks Test to test the following single sample null hypothesis:

H_0: the median of the population is some given value v

The approach we use is to apply the Wilcoxon Signed-Ranks test for paired samples, as described above, on a single sample $\{x_1,\ldots,x_n\}$ where we assume the second sample consists of n values all of which are υ. The assumptions for this test are similar to those of the paired test, namely

- The x_i are independent
- The x_i are interval data (so that ranking can be applied and differences taken)
- The distribution of the x_i is symmetric (or at least not very skewed)

If the second or third assumption is violated, you should consider using the Sign Test.

Real Statistics Excel Functions: The following functions are provided in the Real Statistics Pack:

> **SRANK**(R1, *med*) = *T* for a single sample contained in range R1 less *med*. If the second argument is omitted it defaults to zero.
>
> **SRTEST**(R1, *med, tails*) = p-value for the Signed-Ranks test using the normal distribution approximation for the sample contained in range R1 less *n*. If the second argument is omitted it defaults to zero. *tails* = # of tails: 1 (default) or 2.

These functions ignore any empty or non-numeric cells.

Example 3: Determine whether the memory loss program described in Example 1 of the Sign Test is effective using a two-tailed Wilcoxon Signed-Ranks Test.

We repeat the data from this example in column B of Figure 5.

	A	B	C	D	E	F	G
1	Wilcoxon Signed Ranks Test						
2							
3	Subject	Memory	Median	Diff		T	40.5
4	1	50	20	30		n	14
5	2	15	20	-5		T-crit	21
6	3	25	20	5		p-value	0.4699
7	4	12	20	-8			
8	5	45	20	25			
9	6	3	20	-17			
10	7	45	20	25			
11	8	8	20	-12			
12	9	10	20	-10			
13	10	8	20	-12			
14	11	7	20	-13			
15	12	20	20	0			
16	13	9	20	-11			
17	14	9	20	-11			
18	15	12	20	-8			

Figure 5 – Wilcoxon Signed-Ranks Test for a Single Sample

As shown in Figure 5, the memory data values are compared with the hypothetical median of 20%. . We calculate T to be 40.5 (cell G3) using the formula SRANK(D4:D18) and find the critical value for T when n = 14 to be 21 (two-tail test) from the Wilcoxon Signed-Ranks Table. Since 40.5 > 21, we cannot reject the null hypothesis and conclude once again that there is no significant difference between the median of the data and 20%.

Using the normal distribution approximation, we see that SRTEST(B4:B18,20) = SRTEST(D4:D18) = .225629 > .05 = α, and so again conclude there is no significant difference between the median of the data and 20% (one-tail test).

Note that one way to calculate that n = 14 (cell G4) is to use the formula:

=COUNTIF(B4:B18,"<>"&20).

Real Statistics Function: The Real Statistics Pack also provides the following array function for the sample in range R1 where *med* is the hypothesized median (default = 0). The output includes three different estimates of the p-value of the signed-ranks test, namely based on the normal approximation, the exact test and a simulation. The last two of the tests will be described at the end of this webpage.

SR_TEST(R1, *med, lab, tails, ties, cont, exact, iter*): returns the following values in a 6 × 1 column array: *T*-stat, *z*-stat, *r* effect size and the three types of p-values. If *ties* = TRUE (default), the ties correction is applied. If *cont* = TRUE (default) then the continuity correction is applied. If *lab* = TRUE (default FALSE) then an extra column with labels is included in the output.

If *exact* = TRUE (default FALSE) or if the size of each sample is less than or equal to 500, then the p-value of the exact test is output and if *iter* ≠ 0 then the p-value of the simulation version of the test is output where the simulation consists of samples (default 10,000).

For Example 3, the array formula =SR_TEST(B4:B18,C4,TRUE,,FALSE) returns the array displayed in Figure 6 (two-tailed test):

	AF	AG	AH
3	SR_TEST (ties + continuity)		
4			
5	T-stat	40.5	
6	z-stat	0.722642	
7	effect r	0.193134	
8	p-value	0.4699	
9	p-exact	0.463135	
10	p-simul	0.481	

Figure 6 – Output from SR_TEST for a single sample

Real Statistics Data Analysis Tool: The Real Statistics Resource Pack also provides a data analysis tool which performs the Wilcoxon Signed-ranks Test for one sample, automatically calculating the observed median, *T* test statistic, z-score, p-values and effect size *r*.

For example, to use this data analysis tool for Example 3, press **Ctrl-m** and choose **T Tests and Non-parametric Equivalents** from the menu that is displayed (or the **Misc** tab if using the MultiPage user interface). A dialog box will appear as in Figure 3 in [Mann-Whitney Test for Independent Sample.](#) Enter B3:B18 in the **Input Range**, check **Column headings included with data** and enter 20 for the **Hypothetical Mean/Mean**. Next select the **Non-parametric** and **Single sample** options and make sure that all the **Non-parametric test options** are checked.

When you click on the **OK** button, the output shown in Figure 7 is displayed.

	AA	AB	AC	AD
3	Wilcoxon Signed-Rank Test for a Single Sample			
4				
5	sample median	12		
6	pop median	20		
7	count	15		
8	# unequal	14		
9	T+	40.5		
10	T-	64.5		
11	T	40.5		
12				
13		one tail	two tail	
14	mean	52.5		
15	std dev	15.91383	ties	
16	z-score	0.722642	yates	
17	effect r	0.186585		
18	p-norm	0.23495	0.4699	
19	p-exact	0.231567	0.463135	
20	p-simul	0.2377	0.4674	

Figure 7 – Wilcoxon Signed-Ranks data analysis for a single sample

Note that rows 14 through 18 show the results of the Wilcoxon signed-ranks test using the normal approximation, while the bottom two rows show the p-values of the test using the exact test and simulation respectively.

Since **Use ties correction** is checked, the ties correction is applied in the calculation of the standard deviation (cell AB15) as follows.

=SQRT(AB14*(2*AB8+1)/6-TiesCorrection(B4:B18,AB6)/48)

where the TiesCorrection function is as described in Mann-Whitney Test.

Since the **Use continuity correction** is checked, the 1/2 continuity correction is applied in the calculation of the z-score (cell AB16) as follows:

=ABS(ABS(AB11-AB14)-1/2)/AB15

Exact Test

Click here for a description of the exact version of the Signed Ranks Test using the permutation function.

Simulation

Click here for a description of how to use simulation to determine the p-value for the Signed-Ranks test. This approach takes ties into account.

Confidence Interval of the Median

Click here for a description of how to calculate a confidence interval of the median based on the Wilcoxon Signed Ranks Test.

59 Responses to *Wilcoxon Signed-Ranks Test*

Laetitia Coetzee *says:*

September 26, 2018 at 2:08 pm

I obtained the following results by using the Wilcoxon signed rank test. My sample size was 94. On average the participants' score for the one measurement was 89.17 out of 120 (SD = 20.01) and their score for the other measurement was 100.84 out of 120 (SD = 12.26). The test indicated that a significant difference existed between the two scores measured in the study (z = -4.99, p<.05) with a large effect size as interpreted with Cohen's criteria (r=-0.51).
I have now been asked to report the direction of my results. How do I go about doing that? Any help will be greatly appreciated.
Kind regards

Reply

Charles *says:*
September 26, 2018 at 5:45 pm

Laetitia,
Since 100.84 > 89.17, the direction is that the second population is significant greater than the first population.
Charles

Reply

sebastian *says:*
January 2, 2018 at 10:01 am

Hi Charles,

I have performed the Wilcoxen test, like shown in Table 4.

I do not understand how to decide whether the samples are shifted to the left or to the right?
Can I just compare the medians and if the first is smaller than the second I know that the samples are shifted the the right?

Thanks for your help.

Sebastian

Reply

Charles *says:*
January 3, 2018 at 8:52 am

Sebastian,
When comparing two independent samples using the Mann-Whitney test, you can create histograms of the two samples and see whether the plots look roughly similar (even if shifted right or left). If they are roughly similar, then the test can be used to compare the medians. In this case the medians determine whether one sample is shifted to right (or left) of the other.
Wilcoxon's signed ranks test is used to compare paired samples (not independent sample) and essentially you are looking a one sample which contains the paired differences of the data from the two samples. The median of the difference (not the medians of each sample) will tell you whether the differences between the samples is shifted right or left (from the origin), but the Wilcoxon signed ranks test will tell you whether this shift away from zero is significant or just random.
Charles

Reply

Kiran *says:*
March 20, 2017 at 4:47 am

Hi,
My data sets are matrices. I need to compare two matrices 43×43.
I'm getting an error message that macros aren't compatible
I'm using Excel 2010, Windows 7 64 bit.

Reply

Charles *says:*
March 20, 2017 at 8:22 am

Kiran,
I don't know why you are receiving this message. The usual reason for such a message is that the software wasn't installed properly. If the software is installed correctly, when you press Alt-TI you should see RealStats and Solver on the list of add-ins with check marks next to them.
If not, you need to follow the installation instructions which can be found on the same webpage from where you downloaded the file containing the software.
Charles

Reply

---

kw *says:*
August 11, 2016 at 9:54 am

Thank you for this, it's brilliant. I have been trying to use the Wilcoxon signed ranks test for paired data, however, it is giving me 4.77117E-05 and 9.54233E-05 for a p-value – what should I do to get an actual value?

Reply

Charles *says:*
August 11, 2016 at 10:18 am

Kw,
These are the actual values written in scientific notation. 4.77117E-05 just means 4.77117 times 10 raised to the -5 power. This is the same as 0.0000477117. You can use Excel's formatting capability to change this cell from Scientific format to General format.
Charles

Reply

Johan *says:*
May 26, 2016 at 8:37 am

Consider the following two datasets:
176;176;189;171;173;162;171
176;176;189;171;173;163;170

They are equal except for the last two values, where one value in row 1 is higher than the corresponding value in row 2, and one value is lower. There will only be two ranks: one positive (2) and one negative (-1). The T value will therefore be 1, which is less than the critical value of 2 and the test therefore shows that there is a significant difference between the datasets. They do however have the same mean value, so there should not be any difference between the means?

Am I doing something wrong here?

Reply

Johan *says:*
May 26, 2016 at 8:43 am

Correction: The ranks should be +1.5 and -1.5, but the problem still occurs.

Reply

Charles *says:*
May 26, 2016 at 5:08 pm

Johan,

Yes, you are doing something wrong. The sample size is n = 2, which is too small to use the table of critical values.

If you use the normal approximation (not great either since the sample id very small), you will find that T = 1.5 (Wilcoxon Signed-Ranks Test for Paired Samples). Since mean for the normal approximation = 2*3/2 = 1.5, the z-score = (1.5-1.5)/s.e. = 0. Thus, for a two tailed test p-value = 1-NORMSDIST(0) = 1, and so there is no significant difference between the medians.

If you use the exact test, you will also get a p-value >> .05 (although the values reported are not correct, and so I need to fix these)

Charles

Reply

Johan *says:*

May 27, 2016 at 8:44 am

Thanks for the clarification!

Reply

Eric *says:*

April 18, 2016 at 10:35 am

Hi Charles

First of all, many thanks for creating this very useful tool.

I'm trying to perform a Wilcoxon Signed-Ranks for Paired Samples test using Real Statistics. The problem I keep having is that after inputting my data ranges (1 & 2) and otherwise completing the dialog box, I get the error "invalid input range 1 selected". I'm quite certain I'm selecting only the data range I want. I get this error whether I choose the range with the column headings (and check the column heading box in the RealStats dialog) or not (and leave the corresponding box unchecked).

Any suggestions to get around this issue?

Again, thanks.

Eric

Reply

Charles *says:*

April 19, 2016 at 2:53 pm

Eric,
I have just used the Wilcoxon Signed-Ranks test for Paired Samples and did not see this problem. Perhaps it has something to do with your data. If you send me an Excel file with your data, I will truy to figure out why you are having this problem. You can find my email address at Contact Us.
Charles

Reply

Larry *says:*

March 3, 2016 at 10:36 am

Sir Charles,

Thanks for this site, really helped me a lot as I'm really not a statistician! I hope you would consider my question. I have a paired sample data (n=229), and their differences are actually not symmetric (i.e. I even validated this using the D'Agostino-Pearson Test from your site as well). Considering the asymmetry, I should consider using the sign test but I am quite hesitant and am still trying to look for some way of still using the Wilcoxon-signed-rank test.
I read this dissertation of Mr. Jutharath Voraprateep about "Robustness of Wilcoxon Signed-Rank Test Against the

Assumption of Symmetry". If I was able to understand it correctly, he said that doing the Wilcoxon-signed-rank test after the Inverse transformation method from an arbitrary distribution of the dataset (in our case, the paired difference dataset) to comply the symmetry condition of the test can be done and may be considered.
However in my dataset, some paired difference are negative, and in that, I cannot use log/ln transformation. I still want to use Wilcoxon signed rank test instead of Sign test. Of this whole idea, I hope you could help me with my problems:

1. Is the inverse transformation method that sir Voraprateep said same with the simple transformation method (e.g log10(x), ln(-ln(x)), cube root(x) etc.)? If yes, I've been looking for a transformation method that can handle negative data and at the same time improve the symmetry of the data but up to now, I still can't find one (I objectively test for symmetry of the transformed data using the same D'Agostino-Pearson Test for symmetry). I hope you have some suggestion on what specific transformation formula (dealing with negative values and asymmetric data) I could use/consider.

2. If it would be successful to transform the paired difference data and be able to follow symmetry, Can I use the result of the Wilcoxon Rank signed test for the transformed data to explain the actual paired difference data (i.e whether the changes/difference between the paired sample dataset is significant or not based from the result of the test from the transformed paired difference data).

3. If the whole idea is not appropriate, could you please suggest me of other tests similar to Wilcoxon or even sign test? Even if it's hard, I'm going to study those tests.

I hope I was able to raise my questions/concern clearly and these questions were likewise able to provide further idea for other people who visits and really learn from your lectures and discussions. Thank you very much!

Reply

Charles *says:*
March 13, 2016 at 12:35 pm

Larry,
While log(x) is not defined for negative values of x, log(a+x) is defined provided the constant a is chosen large enough so that it is bigger than the absolute value of the most negative value of x that you have in your sample. This approach might work for you.
Charles

Reply

Cassie *says:*
February 9, 2016 at 2:12 am

What if you have all positive ranks, and no negative ranks? Do I use zero for my T since it's the smaller of the sums (sum of the negative ranks), which makes it smaller than my T-crit (and statistically significant)? Thanks!

Reply

Charles *says:*
February 9, 2016 at 8:05 am

Cassie,
I think that is correct. Since all the signs go in one direction, you would expect that the result is significant.
Charles

Reply

Rotimi Bunmi *says:*
January 27, 2016 at 2:01 pm

How can We proof that Wilcox rank test is consistent

Reply

Charles *says:*
January 27, 2016 at 6:25 pm

Please see the paper Mann & Whitney (1947) referenced in the Bibliography for the proof of the Mann-Whitney test. The proof is probably similar to that for the Signed Ranks test. If not, you could look at Wilcoxon's original paper.
Charles

Reply

Felix *says:*
January 25, 2016 at 6:24 pm

Hi Charles:

1. Can we work a Wilcoxon signed rank with unequal samples? For example:
n1=10 and n2=8
n1=20 and n2=5
n1=1 and n2=10
n1=1000 and n2=50
I saw in the example of husband and wife that the couple number 8 and 30 have a cero and a think we can but I have a doubt…

Reply

Charles *says:*
January 26, 2016 at 8:54 am

Felix,

The Wilcoxon signed rank test is for paired samples, and so there is essentially one sample consisting of pairs. Thus n1 must equal n2. If both members of the pair have the same value the value used by the test for that pair is zero.

Since n1 is not equal to n2 perhaps you are looking to use some other test — maybe the Mann-Whitney test (or even the t test).

Charles

Reply

Sue *says:*
November 18, 2015 at 12:19 am

Hi Charles,

Thank you for explaining the stats so nicely. Your website and RealStat package have been tremendously helpful.
I have one question, though. I ran the Wilcoxon signed rank test using the same dataset, and found SPSS puts out a negative Z value (-1.682), whereas RealStat in Excel puts out a positive Z value (1.631). Not only that, but the p values were slightly different: 0.093 in SPSS, and 0.1029 in RealStat. Would you please explain what can account for these differences in Z and P?
I would be very grateful to hear your opinion on this.
Thank you.

Reply

Charles *says:*
November 23, 2015 at 6:29 pm

Sue,

The z value is probably negative, but I have used the absolute value of the z-value in Real Statistics since it is easier to relate to this value. In any case, the absolute values of z from SPSS should be equal to the z value from Real Statistics.

Without seeing the data, I can't explain why the z values from Excel and SPSS should differ (except for the sign). The likely reason is how ties are handled (e.g. if SPSS automatically corrects for ties and you have not chosen the ties correction in Real Statistics). If you send me an Excel file with your data I will try to figure out why there is a difference.

The fact that the p-values are different is simply a consequence of the z values being different.

Charles

Reply

Cristopher *says:*
November 17, 2015 at 6:56 pm

I was happy when I've found this great site but when I want to start Wilcoxon Signed-Ranks Test for Paired Samples (for 2007) a message pops up "alfa most be a number between 0 and .5". Ofcourse the default value 0.05 is set. I don't know if I'm doing something wrong or something with Excel is not right. I would be realy gratefull for answer about that error.

Reply

Charles *says:*
November 17, 2015 at 8:35 pm

Cristopher,
Even though the default value is .05, you will need to re-enter the value (probably as ,05). You are receiving this message because the software is confused between .05 and ,05 (comma vs. period as the decimal indicator). I have tried to avoid this problem, but it seems to occur with Excel for certain languages.
Charles

Reply

Amani *says:*
October 3, 2015 at 1:29 pm

I have two paired data on the perception of villagers regarding forest management before and after intervention of PFM. I see Wilcoxon is suitable to analyse the data to see if there is significant difference before and after intervention. Please could you provide me with reference of books that I can support my decision?

Thanks for your understanding.

Amani

Reply

Charles *says:*
October 4, 2015 at 9:08 am

Almost any book of statistics that includes nonparametric tests can be used as a reference. Two such references are:

Howell, D. C. (2010). Statistical methods for psychology (7th ed.). Wadsworth, Cengage Learning.

Moore, D., McCabe G. and Craig, B. (2006) Chapter 15 (Non-parametric tests) of Introduction to the practice of statistics, 6th Ed. WH Freeman
http://bcs.whfreeman.com/ips6e/content/cat_040/pdf/ips6e_chapter15.pdf

Charles

Reply

Christo Fab *says:*
July 30, 2015 at 6:40 pm

Dear Charles, I am testing for equality of means between large paired samples ranging in size from n=600-1400, with large and unequal variances. Is the Wilcoxon Signed-Ranks Test for Paired Samples suitable? [When I use the test the null hypothesis is consistently rejected, even when the sample means are very close]

Reply

Charles *says:*
July 31, 2015 at 8:29 am

Christo,

If your data is normally distributed (or at least not too skewed), you could even use the paired t test. Otherwise the Wilcoxon Signed-Ranks test could be used. Recall that in the paired test, the differences between each of the pairs is tests, and so the fact that the individual samples have different variances is not relevant.

With large samples, it is not too surprising that the null hypothesis is rejected, since even a small difference in the means will be statistically significant. In these cases (and even for small samples), you should calculate the effect size. If this statistic is small, you could conclude that there is a significant difference between the means, but that this difference is small.

Charles

Reply

Monica *says:*
June 16, 2015 at 3:59 pm

Hi Charles

Thanks much for this well explained piece of information. I found it very useful as am preparing for my Non-Parametrics and Categorical Statistics.. but how do we compute the p value for the Wilcoxon?

Reply

Charles *says:*
June 16, 2015 at 4:27 pm

Monica,
When the normal approximation is used then the p-value is simply NORMDIST(T,mean,std,TRUE) where T is the calculated T value and mean and std are the approximate mean and standard deviation values (as described on the referenced webpage).
Charles

Reply

---

juan *says:*
June 5, 2015 at 11:30 am

Dear Charles,

I'm using the Data Analysis Tool for Wilcoxon signed-ranks test. However, when I select ties correction the standard deviation is negative and then impossible to calculate the others values.
I'm comparing the judgments of a same group of listeners, using a 5-point scale, concerning two different musical stimuli.

Thanks,
Juan

Reply

Charles *says:*
June 9, 2015 at 4:52 pm

Juan,
Yes, I am seeing the same problem. There is a misplaced parenthesis in the program. I will fix this bug and put it in the next release, which should be available in the next couple of days.
Thanks very much for catching this error.
Charles

Reply

juan *says:*
June 19, 2015 at 4:51 pm

Hi Charles,
Just a question. Will there be a new release for Mac users soon ?
Thanks,
Juan

Reply

Umer *says:*
May 20, 2015 at 12:12 am

Hi Charles,
I performed Wilcoxon Signed Ranks test on two data sets using SPSS. In test statistics, it mentions the basis of the Z-value as either negative ranking or positive ranking. Can I use this logic to obtain an inequality between the two data set? Just like in a paired T-test, if the value of T is negative than we can say that the latter one in the data set is greater than the former one.
Thanks

Reply

Charles *says:*
May 20, 2015 at 6:21 am

Sorry, but I don't understand your question. The Wilcoxon Signed-Ranks test is used as a substitute for the paired t test.
Charles

Reply

Umer *says:*
May 20, 2015 at 11:53 pm

Hi Charles,
In SPSS, the test statistics is given in the form of Z and P value. With every Z-value it is indicated if it was based on positive ranking or negative ranking. While in the rank table it shows that Positive ranking indicates Sample1<Sample2 and vice versa. Can I use this to indication to infer the an inequality relation between the two samples?
Or simply, can this test be used to establish an inequality relation between the two samples?

Reply

Charles *says:*
May 21, 2015 at 6:10 pm

Umer,
Sorry, but I don't completely understand your question. In any case, the Wilcoxon Signed-Ranks test is used to establish an inequality relation between the two samples (assuming they are paired samples).
Charles

Reply

---

giuseppe *says:*
April 24, 2015 at 5:19 pm

Hi Charles,
in Wilcoxon Single Sample Test which is the scale of effect r that i have to see? Cohen's scale?
Best regards,
gp

Reply

Charles *says:*
April 25, 2015 at 7:29 am

No you shouldn't use the Cohen's scale.
A rough estimate of effect size is that r=.5 represents a large effect size (explains 25% of the variance), r=.3 represents a medium effect size (explains 9% of the variance), and r=.1 represents a small effect size (explains 1% of the variance).
Charles

Reply

giuseppe *says:*
May 16, 2015 at 7:39 pm

Hi Charles,
sorry.....but where can I find references on the estimates that I have listed?
My problem is:
I have a distribution(X) on which I perform the Wilcoxon Signed-Rank Test for a Single Sample.
H0: X=0 ; H1: X != 0
The value of "effect r" is : 0,874474.
how can I interpret this value based on my hypothesis?

Reply

Charles *says:*
May 18, 2015 at 7:41 am

A rough estimate of effect size is that r = .5 represents a large effect size (explains 25% of the variance), r = .3 represents a medium effect size (explains 9% of the variance), and r = .1 represents a small effect size (explains 1% of the variance). Your value of r represents a very large effect. explaining over 76% of the variance.
Charles

Reply

Adam *says:*
January 30, 2015 at 11:13 pm

In the PERMDIST(T, n, TRUE) formula, is T the value outputed above the sig(exact) in the table produced? So for figure 4, would it be PERMDIST(116, 30, TRUE)

Reply

Charles *says:*
January 31, 2015 at 7:56 am

Adam,
The value for T is 90, as shown in cell U13. Thus the calculation is PERMDIST(90, 30, TRUE).
Caution: since n = 30, this formula will take a while to calculate.
Charles

Reply

Adam *says:*
February 2, 2015 at 3:18 pm

Great, thanks for your help.

Reply

Ada, *says:*
January 27, 2015 at 4:28 pm

I am wondering why I am getting different p values when I do this test in excel versus doing it in SAS. The p values are pretty different when using less than 20 observations, and SAS says "If n<20 , the significance of is computed from the exact distribution of S, where the distribution is a convolution of scaled binomial distributions."

The T criticial values are the same but p values of 2 tail are different.

When I use this excel add in, running the exact test and unchecking the exact test produce the same results. is that normal?

SAS:
http://support.sas.com/documentation/cdl/en/procstat/63104/HTML/default/viewer.htm#procstat_univariate_sect029.htm

Reply

Charles *says:*
January 28, 2015 at 11:33 pm

Ada,

When using the Real Statistics **Wilcoxon Signed-Ranks** data analysis tool both the one-tail and two-tail tests are shown using the **normal approximation**. This test outputs the T-crit, p-value and whether the test is significant or not. The result is the same whether the **Include exact test** option is checked or not.

If the **Include exact test** option is checked then **in addition** an exact test is displayed. This test shows the critical value based on the Wilcoxon Signed-Ranks Table and whether the T value is significant or not (no p-value is displayed).

In addition, you can conduct another version of the exact test using the PERMDIST(T, n, TRUE) formula (but not included in the data analysis tool). This version outputs a p-value, and may be equivalent to the output from SAS with n < 20 (I don't have a copy of SAS and so I can't check). I plan to update the website to make this clearer in the next day or two. Charles

Reply

Sue *says:*
December 18, 2014 at 1:51 pm

Dear Charles,

I would like to do a Wilcoxon test to compare to sets of nonparametric paired data. I have downloaded the realstats package and activated it in the add-ins. When I open the data analysis window, the SRank options do not show. Am I missing something?

Many thanks for your help,
Sue

Reply

Charles *says:*
December 18, 2014 at 10:21 pm

Sue,

SRank is a function and so you should enter it into a cell as you would the SUM, AVERAGE or other Excel functions

You can access the Wilcoxon Signed-Ranks Test, as described towards the end of the referenced webpage, as follows:

Press Ctrl-m and choose the **T Tests and Non-parametric Equivalents** data analysis tool from the menu that is displayed. On the dialog box that appears choose the **One sample** and **Non-parametric** options, and fill in the appropriate fields.

Charles

Reply

Sue *says:*
December 22, 2014 at 10:49 am

Hi Charles,
Thanks for your help.
Sue

Reply

Fernando *says:*
October 31, 2014 at 5:11 pm

Thank you for putting together this functions for excel.
I am trying to use the SRANK_TEST but it doesn't returns the whole table that is supposed to return. What do you think I am missing? Once I place the function it returns T-Test on one single cell.

Reply

Charles *says:*
October 31, 2014 at 6:58 pm

Fernando,
Based on your comment, I don't understand the problem that you are having. If you send me the data set that you are testing, I will try to figure out what the problem is.
Charles

Reply

Deon *says:*
September 23, 2014 at 7:43 pm

Is there a critical value table or calculator for large sample sizes? The two sample sizes I have is n1=75 and n2=171

Reply

Charles *says:*
September 23, 2014 at 8:39 pm

Deon,
For large samples you should use the normal approximation described in Examples 2 and 3 of the referenced webpage. These examples use Property 1 described on that webpage.
Charles

Reply

kiconco chrissy *says:*
September 17, 2014 at 4:41 pm

which parametric test matches with wilcoxon test

Reply

Charles *says:*
September 17, 2014 at 7:44 pm

The Wilcoxon signed ranks test for a single sample matches with the one-sample t test.
The Wilcoxon signed ranks test for paired samples with the paired samples t test.
Charles

Reply

Gary *says:*
August 28, 2014 at 11:52 pm

Charles,

Can you double check your formula for calculating the effect size for the Wilcoxon Signs Rank Test?

This source uses N, whereas yours uses 2N:

http://www.let.rug.nl/~heeringa/statistics/stat03_2013/lect09.pdf

Thanks,

Gary

Reply

Charles *says:*
August 31, 2014 at 8:06 am

Gary,
In the reference N is the total number of observations on which z is based. I believe N = 2n where n = total number of paired samples since each pair has two observations.
Charles

Reply
