

## Mann-Whitney Test

For  $n_a=8$ ;  $n_b=8$ .

The logic and computational details of the Mann-Whitney test are described in Subchapter 11a of [Concepts and Applications](#).

In order to apply the Mann-Whitney test, the raw data from samples A and B must first be combined into a set of  $N=n_a+n_b$  elements, which are then ranked from lowest to highest, including tied rank values where appropriate. These rankings are then re-sorted into the two separate samples.

If your data have already been ranked, these ranks can be entered directly into the cells headed by the label «Ranks». In this case, please note that the sum of all ranks for samples A and B combined must be equal to  $[N(N+1)]/2$ . If this equality is not satisfied, you will receive a message asking you to examine your data entry for errors.

If your data have not yet been rank-ordered in this fashion, they can be entered into the cells labeled «Raw Data» and the ranking will be performed automatically. There is also an option, below, for importing raw data from a spreadsheet.

After data have been entered, click one or the other of the «Calculate» buttons according to whether you are starting out with ranks or raw data.

- The value of  $U$  reported in this analysis is the one based on sample A, calculated as

$$U_A = n_a n_b + \frac{n_a(n_a+1)}{2} - T_A$$

where  $T_A$  = the observed sum of ranks for sample A, and

$$n_a n_b + \frac{n_a(n_a+1)}{2} = \text{the maximum possible value of } T_A$$

- With relatively small samples, the calculated value of  $U_A$  can be referred directly to the sampling distribution of  $U_A$ . For cases where  $n_a$  and  $n_b$  both fall between 5 and 21, inclusive, the lower and upper limits of the critical intervals of  $U_A$  are calculated by this page and placed in the designated table below. If either of the samples is of a size smaller than 5, additional instructions will be given below.
- As  $n_a$  and  $n_b$  increase, the sampling distribution of  $T_A$  becomes a reasonably close approximation of the unit normal distribution. If  $n_a$  and  $n_b$  are both equal to or greater than 5, this page will also calculate the value of  $z$ , along with the corresponding one-tailed and two-tailed probabilities. Note, however, that the approximation to the normal distribution is best when  $n_a$  and  $n_b$  are both equal to or greater than 10.

### *Option for Importing Raw Data via Copy & Paste:*␣

Within the spreadsheet application or other source of your data, select and copy the column of data for sample A. Then return to your web browser, click the cursor into the text area for sample A and perform the 'Paste' operation from the 'Edit' menu. Perform the same procedure

for sample B. In importing raw data into the Mann-Whitney test, it is absolutely essential that the numbers of data items for samples A and B are precisely the same as the values of  $n_a$  and  $n_b$  that you have specified in setting up this page. For each sample, make sure that the final entry in the list is not followed by a carriage return. To perform this check, click the cursor immediately to the right of the final entry in the list, then press the down-arrow key. If an extra line is present, the cursor will move downward. Extra lines can be removed by pressing the down-arrow key until the cursor no longer moves, and then pressing the 'Backspace' key (on a Mac platform, 'delete') until the cursor stands immediately to the right of the final entry.  $\uparrow$

### Import Raw Data $\uparrow$

Sample A	Sample B	
0.016	0.361	<a href="#">Import data to data cells</a> <hr/> <a href="#">Clear A</a> <hr/> <a href="#">Clear B</a>
0.039	0.361	
0.047	0.278	
0.054	0.041	
0.158	0.528	
0.267	0.250	
0.325	0.250	
0.506	0.556	

### Data Entry: $\uparrow$

count	Ranks for		Raw Data for	
	Sample A	Sample B	Sample A	Sample B
1	1	12.5	0.016	0.361
2	2	12.5	0.039	0.361
3	4	10	0.047	0.278
4	5	3	0.054	0.041
5	6	15	0.158	0.528
6	9	7.5	0.267	0.250
7	11	7.5	0.325	0.250
8	14	16	0.506	0.556
<a href="#">Reset</a>	<a href="#">Calculate from Ranks</a>		<a href="#">Calculate from Raw Data</a>	

Mean Ranks for					
Sample A	Sample B	$U_A =$		$P_{(1)}$	$P_{(2)}$
6.5	10.5	$z =$	-1.63	0.0516	0.1031

Note that mean ranks are provided only for descriptive purposes. They

are not part of the Mann-Whitney test. ~ Note also that the z-ratio is calculated only if  $n_a$  and  $n_b$  are both equal to or greater than 5.

Critical Intervals of  $U_A$  for  $n_a=8; n_b=8$  Q

	Level of Significance for a		
	Directional Test		
	.05	.025	.01
	Non-Directional Test		
	--	.05	.02
lower limit	15	12	9
upper limit	49	52	55

The observed value of  $U_A$  is significant at or beyond the designated level if it is equal to or smaller than the indicated lower limit for that level or equal to or greater than the upper limit. It is non-significant if it is larger than the lower limit and smaller than the upper limit.

The adjacent critical intervals are calculated only if  $n_a$  and  $n_b$  both fall between 5 and 21, inclusive. For sample sizes smaller than 5, you can refer your results to a standard table of Mann-Whitney critical values, such as the following, provided by the Department of Mathematics & Statistics at the University of Saskatchewan:

<http://math.usask.ca/~laverty/S245/Tables/wmw.pdf>

with  $n_a=8, n_b=8, U_A= 48$ , and  $U_B= 16$

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