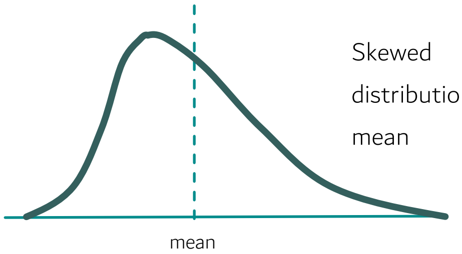
The Mann Whitney U Test

The Mann Whitney U test is a statistical test used by geographers to determine whether there is a significant difference between values observed in two separate samples of the same data variable. It is designed to be used for data sets that are not known, or not believed to exhibit, a normal pattern of distribution around the mean.



Skewed (not normal) distribution around the mean

The test works by ranking the values in a combined data set and seeing to what extent the two samples occupy different extremes of the ranking spectrum. It should only be used for data sets of twenty or fewer samples each.

In practise, the test can be used in many different ways to further geographical research. Here are some examples of data sets that might be analysed using the Mann Whitney U test:

- Demography - determining the difference between the **age structure** of different ethnic groups in an area
- Ecology - researching a difference between **soil moisture content** in managed and unmanaged grassland
- Development - measuring the differences in **gender balance** across a range of schools in two countries or regions
- Rivers - researching the differing **sizes of bedload** samples in the upper and middle courses of a river
- Environmental - determining if there is a significant difference in the **carbon footprint values** exhibited by urban and rural dwellers
- Weather - researching the difference between the daily number of **sunshine hours** witnessed in a given fortnight in two consecutive years
- Settlement - research into different **property values** in two contrasting settlement centres
- Industry - measuring the differences in a range of **environmental impact scores** for an industrial and a deindustrialised site.

How to carry out the Mann Whitney U test

In this example we will look at favourability scores and how they may vary between two different cohorts. The geographical researcher was looking into the impact a new sports development would have on an urban park. Planning permission had been sought to build a community tennis court, with parking and access routes, at one end of a green space found in the centre of the town.

The researcher believed that there would be a difference in opinion about the proposed development depending on how close someone lived to the park. This created the following hypothesis in the mind of the researcher:

"There is a significant difference in favourability between those respondents who live within 2km of the park and those that live further away."

The researcher collected the following data through an on-the-street poll of people:

Respondent number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Distance from park (km)	0.1	8.0	2.5	0.9	0.3	1.5	1.8	0.6	1.2	3.9	2.2	4.5	2.0	1.5	0.7
Favourability score (%)	65	70	55	75	45	70	35	75	80	50	85	75	40	65	100

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Respondent number	16	17	18	19	20	21	22	23	24	25
Distance from park (km)	5.3	3.2	0.9	2.0	1.9	6.5	3.0	2.1	1.5	2.5
Favourability score (%)	65	20	60	80	65	35	40	40	30	60

This data was then sorted by distance: the favourability scores of those living within and more than 2km of the park.

≤ 2km from park	65	75	45	70	35	75	80	40	65	100	60	80	65	30
> 2km from park	70	55	50	85	75	65	20	35	40	60				

The total sample was then placed in rank order from least favourable to most, with rank values applied. The rank value was split and shared if two samples had the same favourability score.

Distance category	>	≤	≤	>	≤	>	≤	>	>	≤	>	≤	≤	≤	>	≤
Favourability score	20	30	35	35	40	40	45	50	55	60	60	65	65	65	65	70
Rank	1	2	3.5	3.5	5.5	5.5	7	8	9	10.5	10.5	13.5	13.5	13.5	13.5	16.5

Continued...

Distance category	>	≤	≤	>	≤	≤	>	≤
Favourability score	70	75	75	75	80	80	85	100
Rank	16.5	19	19	19	21.5	21.5	23	24

The researcher then totalled the rank values (Σr) for each of the ≤2km sample and the >2km sample and counted the number of records in each sample (n).

≤2km : $\Sigma r_1 = 190.5$ $n_1 = 14$

>2km: $\Sigma r_2 = 109.5$ $n_2 = 10$

These values could then be used in the Mann Whitney U test equation to give a U value for each sample:

$$U_1 = n_1 n_2 + \frac{n_1 (n_1 + 1)}{2} - \Sigma r_1$$

$$U_1 = 14 \times 10 + \frac{14 (14 + 1)}{2} - 190.5$$

$$U_1 = 140 + 105 - 190.5 \quad = 54.5$$

$$U_2 = n_1 n_2 + \frac{n_2 (n_2 + 1)}{2} - \Sigma r_2$$

$$U_2 = 14 \times 10 + \frac{10 (10 + 1)}{2} - 109.5$$

$$U_2 = 140 + 55 - 109.5 \quad = 85.5$$

The smaller of the two U values is always taken to be the calculated value (in this case $U_1 = 54.5$).

The calculated value holds no true meaning on its own. To find out if the hypothesis can be accepted the researcher needs to compare it with a critical value derived from a significance table. One reads off the critical value using n_1 and n_2 and if the calculated value is less than the critical value, the hypothesis can be accepted. A full significance table for the Mann Whitney U test can be downloaded from the island geographer site.

In this case, to a 95% significance level, the critical value is 36. Therefore, the researcher can accept the hypothesis.