Mann Whitney U-Test

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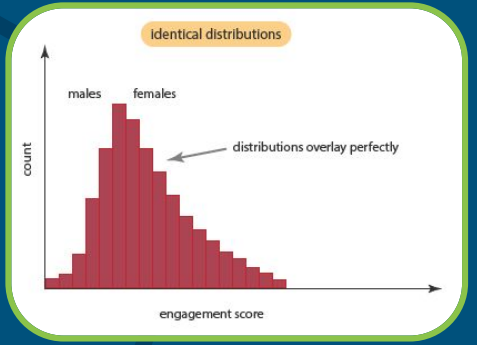
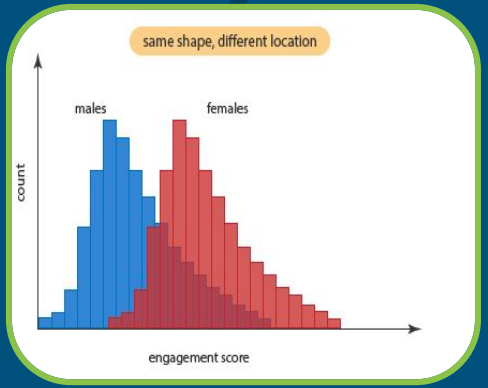
Background

The **Mann-Whitney U-Test** is a **non-parametric test** used to compare two independent populations.

It compares the **null hypothesis** to the **two-sided** research hypothesis for differences or similarities.

It tests whether **two independent samples** originate from the **same population.**





When should you use the test?

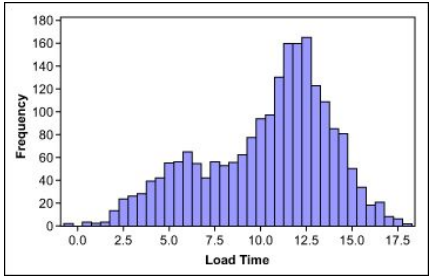
The **Mann-Whitney U-Test** is commonly used to see whether two separate samples are from the same population.

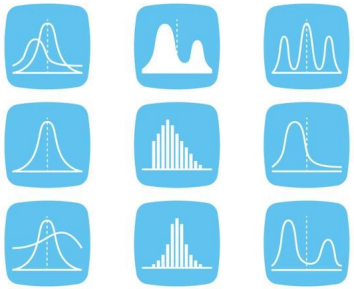
The **Mann Whitney U-Test** is used when the requirements of the t-test are not met.

The **Mann Whitney U-Test** is known to give the most accurate representation of significance.

Parametric vs. Nonparametric

A **parametric test** assumes that the population follows a known **distribution.**





A **non-parametric test** does not make any assumptions about the population's distribution.

Presentation & Interpretation

How should the test be implemented and interpreted?

The **Mann-Whitney U Test** allows for the calculation of it's **U statistic,** a test of **statistical significance.**

If the calculated **U value** is **less than** its corresponding **U-critical value,** the null hypothesis is **rejected**.

The **U-statistic** can also be used to calculate the samples' **p-values**, or another measure of significance.

$$U_a = (n_a * n_b) + \frac{n_a * (n_a + 1)}{2} - T_a$$

U-Critical Values Table

Table A5.07: Critical Values for the Wilcoxon/Mann-Whitney Test (U)

Nondirectional α=.05 (Directional α=.025)

	n_2																			
n_1	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	0	0	0	0	1	1	1	1	1	2	2	2	2
3	-	-	-	-	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8
4	-	-	-	0	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	13
5	-	-	0	1	2	3	5	6	7	8	9	11	12	13	14	15	17	18	19	20
6	-	-	1	2	3	5	6	8	10	11	13	14	16	17	19	21	22	24	25	27
7	-	-	1	3	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
8	-	0	2	4	6	8	10	13	15	17	19	22	24	26	29	31	34	36	38	41
9	-	0	2	4	7	10	12	15	17	21	23	26	28	31	34	37	39	42	45	48
10	-	0	3	5	8	11	14	17	20	23	26	29	33	36	39	42	45	48	52	55
11	-	0	3	6	9	13	16	19	23	26	30	33	37	40	44	47	51	55	58	62
12	-	1	4	7	11	14	18	22	26	29	33	37	41	45	49	53	57	61	65	69
13	-	1	4	8	12	16	20	24	28	33	37	41	45	50	54	59	63	67	72	76
14	-	1	5	9	13	17	22	26	31	36	40	45	50	55	59	64	67	74	78	83
15	-	1	5	10	14	19	24	29	34	39	44	49	54	59	64	70	75	80	85	90
16	-	1	6	11	15	21	26	31	37	42	47	53	59	64	70	75	81	86	92	98
17	-	2	6	11	17	22	28	34	39	45	51	57	63	67	75	81	87	93	99	105
18	-	2	7	12	18	24	30	36	42	48	55	61	67	74	80	86	93	99	106	112
19	-	2	7	13	19	25	32	38	45	52	58	65	72	78	85	92	99	106	113	119
20	-	2	8	14	20	27	34	41	48	55	62	69	76	83	90	98	105	112	119	127

Using the Mann Whitney U-Test

Is there a difference in SAT scores in public versus private schools?

The Dataset

- The Mann-Whitney U Test is used to deal with **small datasets.**
- ***20*** public school average SAT scores and ***20*** private average SAT scores were randomly sampled from a dataset.

	Public	Private
0	892	1410
1	1188	1230
2	939	1240
3	893	1170
4	858	1400
5	1067	1340
6	1003	1100
7	973	1320
8	1286	1410
9	1121	1090
10	1325	1109
11	1089	1230
12	889	1110
13	1153	1412
14	846	1340
15	1203	1210
16	982	1340
17	1077	1410
18	996	1170
19	1118	1340

Calculation of U-Statistic

Equations
$U_1 = n_1n_2 + n_1(n_1 + 1)/2 - R_1$
$U_2 = n_1n_2 + n_2(n_2 + 1)/2 - R_2$

- *T* represents a sum of the sample's ranked numbers (1-20 in ascending order).
- N_x is the number of datapoints in each sample.

https://wpi0-my.sharepoint.com/:x:/g/personal/gprabhakar_wpi_edu/ETgJ7ikAKOFGpqxWElbfA3cBkgSYJTgobvE3Yxb9caVppA?e=gITgNM

Calculation of U-statistic and P-value with Python

$$U_a = (n_a * n_b) + \frac{n_a * (n_a + 1)}{2} - T_a$$

- Python's *Scipy.stats* has a variety of statistical tests (one of these being the Mann-Whitney U-Test)
- Load excel file with data, calculate U-statistic and P-value, and upload a CSV

```
Public School SAT Score Average: 1044.9, Max: 1325

Private School SAT Score Average: 1269.05, Max: 1412

 MannwhitneyuResult(statistic=45.0, pvalue=1.4423747959436654e-05)
```

Conclusions

Private Schools have a **statistically significantly higher** average SAT Score than public schools.

The **Mann-Whitney U-Test** can be used to test for accurate statistical significance in small samples.

Interpretation: In the Literature

APPLICATION OF MANN-WHITNEY U TEST IN RESEARCH OF PROFESSIONAL TRAINING OF PRIMARY SCHOOL TEACHERS

Zivorad M. Milenovic, MSc

Does full classroom versus specific subject teaching play a role in the professional development of primary school teachers?

Interpretation: In the Literature

	Professional development
Mann-Whitney U	1302,000
Wilcoxon W	2787,000
Z	-1,018
Asymp. Sig. (2-tailed)	,309

Interest	N	Mean Rank	Sum of Ranks
Professional development class teacher	44	51,61	2787,00
subject teachers	64	57,39	3099,00
Total	108		

Interest	N	Median
class teacher	44	25,0000
subject teachers	64	45,0000
Total	108	35,0000

Interpretation: In the Literature

- Z-statistic is -1.018, which is higher than 0.05.
  - Therefore, the samples are not significantly different.
- **The author uses this assumption to say that the Mann-Whitney U statistic of 1302 is higher than its critical value.**

	Professional development
Mann-Whitney U	1302,000
Wilcoxon W	2787,000
Z	-1,018
Asymp. Sig. (2-tailed)	,309

Infographic

https://create.piktochart.com/output/42673779-mann-whitney-u-test

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Table A5.07: Critical Values for the Wilcoxon/Mann-Whitney Test (U) . (n.d.). Retrieved November 22, 2019, from https://math.usask.ca/~laverty/S245/Tables/wmw.pdf.

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