

Practical No. 7 : Mann-Whitney test

The manufacturer of a hot tub is interested in testing two different heating elements for its product. The element that produces the maximum heat gain after 15 minutes would be preferable. The manufacturer obtains 10 samples of each heating unit and tests each one. The heat gain after 15 minutes (in °F) follows.

Unit 1	25, 27, 29, 31, 30, 26, 24, 32, 33, 38
Unit 2	31, 33, 32, 35, 34, 29, 38, 35, 37, 30

Enter this data in Minitab and generate the following reports:

Questions :

- Is there any reason to suspect that one unit is superior to the other? Use $\alpha = 0.05$ and the Wilcoxon rank sum test.
- Use the normal approximation for the Wilcoxon rank sum test. Assume that $\alpha = 0.05$. What is the approximate *P*-value for this test statistic?

Solution :

Step 1 : Type your data into the data pane of a worksheet. Make sure you put your data into columns. Use column header for "Unit 1" and "Unit 2". Type the "Unit 1" data into column C1 and "Unit 2" data into column C2.

Step 2 : To perform Mann-Whitney test, under the drop-down menu "STAT", choose "Nonparametrics" then "Mann-Whitney...". A "Mann-Whitney" dialogue box will appear. Set the "First Sample:" as "C1 Unit 1" and "Second Sample:" as "C2 Unit 2" from the table on the left. Set the "Confidence Interval:" as 95.0 and the "Alternative:" as "not equal". Click "OK".

Step 3 : For the descriptive statistics, under the drop-down menu "Stat", choose "Basic Statistics" then "Display Descriptive Statistics...". A "Display Descriptive Statistics" dialogue box will appear. In the "Variables:" box, choose "C1 Unit 1" and "C2 Unit 2" from the table on the left. Click the "Statistics..." option. A "Display Descriptive Statistics: Statistics" dialogue box will appear. Check the "Mean", "Minimum", "Maximum", "First quartile", "Median" and "Third quartile" checkboxes. Click "OK". Click "OK" again.

Step 4 : For the boxplot of "Unit 1" and "Unit 2", under the drop-down menu "Graph", choose "Boxplot". A "Boxplots" dialogue box will appear. Choose "Simple" under "Multiple Y's". Click "OK". A "Boxplot: Multiple Y's, Simple" dialogue box will appear. In the "Graph variables:" box, choose "C1 Unit 1" and "C2 Unit 2" from the table on the left. Click "OK". The following boxplot will be generated.

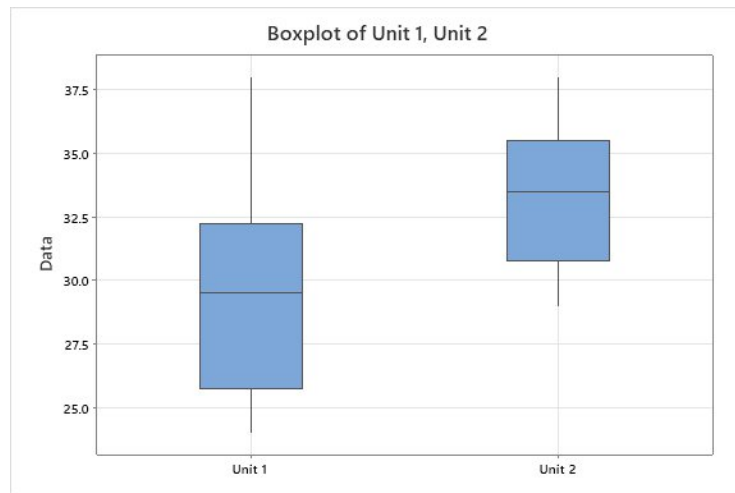


Fig 1 : Boxplot of Unit 1 and Unit 2

Interpretation :

The box and whisker plot shows that the heat gain of unit 1 highly variable while the heat gain of unit 2 is less variable. The distribution of heat gain of unit 1 is slightly right skewed while the distribution of heat gain of unit 2 is almost symmetrical.

Descriptive Statistics :

Variable	Mean	Minimum	Q1	Median	Q3	Maximum
Unit 1	29.50	24.00	25.75	29.50	32.25	38.00
Unit 2	33.400	29.000	30.750	33.500	35.500	38.000

Interpretation :

The descriptive statistics shows that the median heat gain of unit 1 (29.50) is significantly lower than the median heat gain of unit 2 (33.50). It shows the quality of unit 2 is better than the unit 1, because average temperature reached after 15 minutes of operation is higher in unit 2 type coil. So, considering median temperature reached after 15 minutes of operation, variation and shape of the distribution, Unit 2 is superior than the unit 1. So, manufacturer is advised to purchase unit 2 heating elements for manufacturing bath tub.

Estimation for Difference :

Difference	CI for Difference	Achieved Confidence
-4	(-8, 0.0000000)	95.48%

Method :

η_1 : median of Unit 1

η_2 : median of Unit 2

Difference: $\eta_1 - \eta_2$

Hypothesis :

Null hypothesis $H_0: \eta_1 - \eta_2 = 0$

Alternative hypothesis $H_1: \eta_1 - \eta_2 \neq 0$

Test :

Method	W-Value	P-Value
Not adjusted for ties	77.00	0.038
Adjusted for ties	77.00	0.037

Conclusion :

The Mann-Whitney test shows that the p-value (0.038) is smaller than the significance probability (0.05), we reject the null hypothesis at 5 % level of significance. Hence the median heat gain after 15 mins of operation of two different units are not same.

Worksheet :

↓	C1	C2	C3
	Unit 1	Unit 2	
1	25	31	
2	27	33	
3	29	32	
4	31	35	
5	30	34	
6	26	29	
7	24	38	
8	32	35	
9	33	37	
10	38	30	