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Good science, bad science: Questioning research practices in psychological research

Bakker, M.

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Appendix A

Appendix to Chapter 5

Mann-Whitney-Wilcoxon test

A non-parametric method to test to compare two populations is the Mann-Whitney-Wilcoxon test (Mann & Whitney, 1947; Wilcoxon, 1945). Both independent samples $X_1, X_2, ..., X_m$ and $Y_1, Y_2, ..., Y_n$ are put in ascending order. All values are replaced by ranks ranging from 1 to $m + n$. When there are tied groups, take the rank to be equal to the midpoint of the group. The ranks of each group are added and then the lowest of these ranks is the test statistic W. W can be transformed in a Z score by:

$$Z = \frac{W - \overline{W}}{SE_{\overline{W}}} \text{ , where}$$

$$SE_{\overline{W}} = \sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}} \text{ .}$$

The null hypothesis is rejected if

$$|Z| \geq z_{1-\alpha/2} \text{ ,}$$

where $z_{1-\alpha/2}$ is the 1-a/2 quantile of standard normal distribution.

Yuen-Welch test

A robust method for comparing trimmed means is the Yuen-Welch Test (Yuen, 1974). n_j is the sample size associated with the jth group, and h_j is the number of observation left in the jth group after trimming. Put the remaining observations in ascending order yielding $X_{(1j)} \leq \cdots \leq X_{(nj)}$. The trimmed mean of the jth group and can be estimated with:

$$\overline{X}_{tj} = \frac{1}{h_j} \sum_{i=g_j+1}^{n_j-g_j} X_{(ij)} \text{ ,}$$

and the Winsorized mean and variance with:

$$\overline{X}_{wj} = \frac{1}{n_j} \sum_{i=1}^{n_j} X_{wij} \text{ , where}$$

$$X_{wij} = X_{(g_j+1)j} \text{ if } X_{ij} \leq X_{(g_j+1)j}$$

$$= X_{ij} \text{ if } X_{(g_j+1)j} < X_{ij} < X_{(n_j-g_j)j}$$

$$= X_{(n_j-g_j)j} \text{ if } X_{ij} \geq X_{(n_j-g_j)j}$$

$$s_{wj}^2 = \frac{1}{n_j - 1} \sum_{i=1}^{n_j} (X_{ij} - \overline{X}_{wj})^2 \text{ .}$$

Yuen's test statistic is calculated with:

$$T_y = \frac{\overline{X}_{t1} - \overline{X}_{t2}}{\sqrt{d_1 + d_2}} \text{ , where}$$

$$d_j = \frac{(n_j - 1)s_{wj}^2}{h_j(h_j - 1)} \text{ .}$$

The degrees of freedom are:

$$\hat{v}_y = \frac{(d_1 + d_2)^2}{\dfrac{d_1^2}{h_1 - 1} + \dfrac{d_2^2}{h_2 - 1}} \text{ .}$$

The null hypothesis is rejected if

$$\left|T_y\right| \geq t \text{ ,}$$

where t is the 1-a/2 quantile of Student's T distribution with v_y degrees of freedom.