Worst-Case Resistance Testing: Help File for FileDrawPaper2022.xlsm

Overview

This spreadsheet includes calculations for the paper, “Worst Case Resistance Testing: A Nonresponse Bias Solution for Today’s Behavioral Research Realities”, which proposes a method of nonresponse assessment based on meta-analytical file-drawer techniques, also known as worst-case resistance testing (WCRT), and suitable for a wide range of data collection scenarios. A general method is devised to estimate the number of significantly different nonrespondents it would take to significantly alter the results of an analysis. Estimates of nonrespondents can be plotted against effect sizes using “n-curves”, with similar interpretation to p-curves or power curves. Variants of the general method are derived for tests of means and correlations. A sample using a well-established survey instrument from previous behavioral research is used to test the method.

The spreadsheet contains worksheets implementing the general WCRT (worst case resistance testing) method for different statistical tests. Some general points applicable to all spreadsheets are given below.

1. The spreadsheet is built under a GPL-3.0 license. Please see details at <https://www.gnu.org/licenses/gpl-3.0.en.html>.
2. The spreadsheet is a development version designed to help reviewers evaluate the associated paper. The macro code and cell formulas are not protected, so altering any of these values will change the behavior of the spreadsheet.
3. In the spreadsheet, parameters controlled by the user are highlighted in light green and spreadsheet formulas are highlighted in orange.

Single Sample Test

The single sample test worksheet implements a macro to implement WCRT (worst case resistance testing) for single sample t and z tests. The user enters the data, the type of hypothesis, the direction of the hypothesis, the Type I error α for the test (divide by two if a two-tailed test), the range of standard effect sizes, and the spreadsheet algorithm calculates the value of N required to reverse the value of the statistical test for the standard effect size.

Figure 1: Single Sample Macro Worksheet

Graphical user interface, application, table, Excel

Description automatically generated

The worksheet is given in Figure 1. The parameter settings and formulas are on the left. The two buttons on the left run the algorithm. The source data are in column E and the output starts in column F. The information in Figure 1 is described more fully in Table 1.

Table 1: Sheet Descriptions for Single Sample Tests

|  |  |  |
| --- | --- | --- |
| **Component** | **Type** | **Description** |
| Mu(0) | Input | The hypothesized μ0 for the statistical test. |
| Alpha | Input | The Alpha (α) for the statistical test. As the algorithm only checks in one direction to either make a non-significant result significant or vice versa, for two tailed tests the value of α should be divided by two. |
| IsRight | Input | If TRUE, search in the right tail and if FALSE then search in the left tail. |
| zcrit | Formula | The critical value for a single sample z test given the “Alpha” and “IsRight” parameters defined above. |
| tcrit | Formula | The critical value for a single sample t test given the “Alpha” and “IsRight” parameters defined above, with the value of n calculated from the data given in column D. |
| xBar1 | Formula | The sample mean for the data in column D. |
| s1 | Formula | The sample standard deviation for the data in column D. |
| n1 | Formula | The sample size for the data in column D. |
| Cohend1 | Formula | The effect size for the data. |
| zt1 | Formula | The z-score for the data. |
| IsSignifz | Formula | TRUE if the test is significant given the values of  “zcrit” and “IsRight”. FALSE otherwise. |
| IsSignift | Formula | TRUE if the test is significant given the values of  “tcrit” and “IsRight”. FALSE otherwise. |
| sMult | Input | The multiplier for the standard deviation in the WCRT sample, defaults to 1, i.e., same standard deviation as data sample. |
| s2 | Formula | The standard deviation of the WCRT sample, which is “s1” multiplied by “sMult”. |
| Min d2 | Input | The minimum WCRT standard effect size to be tested. |
| Max d2 | Input | The maximum WCRT standard effect size to be tested. |
| Increment | Input | The increment in the WCRT effect size, moving from Min d2 to Max d2. |
| Converge | Input | The convergence criteria for the fixed-point algorithm (the smaller, the more accurate). Defaults to 1.00E-08. |
| OutCol | Input | The column where the output data starts. |
| Run z | Button | Uses a fixed-point algorithm to calculate the number of items required to negate the result of the statistical test for the effect sizes defined by Min d2, Max d2, and Increment. |
| Run t | Button | As above, but for the t-test. |
| X1 | Data | The column containing the sample data. |
| d2 | Output | The effect size for the WCRT data. |
| X2 | Output | The X value, given the effect size “d2” and standard deviation “s2. |
| XC | Output | The combined mean for both the data sample and the WCRT data. |
| SC | Output | The combined standard deviation for both the data sample and the WCRT data. |
| N2 | Output | The value of N in the WCRT sample required to negate the result of the statistical technique for an effect size of “d2”. |
| N2Opt | Output | Estimate of “N2” from the fixed point algorithm. |
| Diff | Diff | The absolute value of “N2-N2Opt”. The algorithm converges when this is below the value in “Converge”. |

Two-Sample Test (not in Paper)

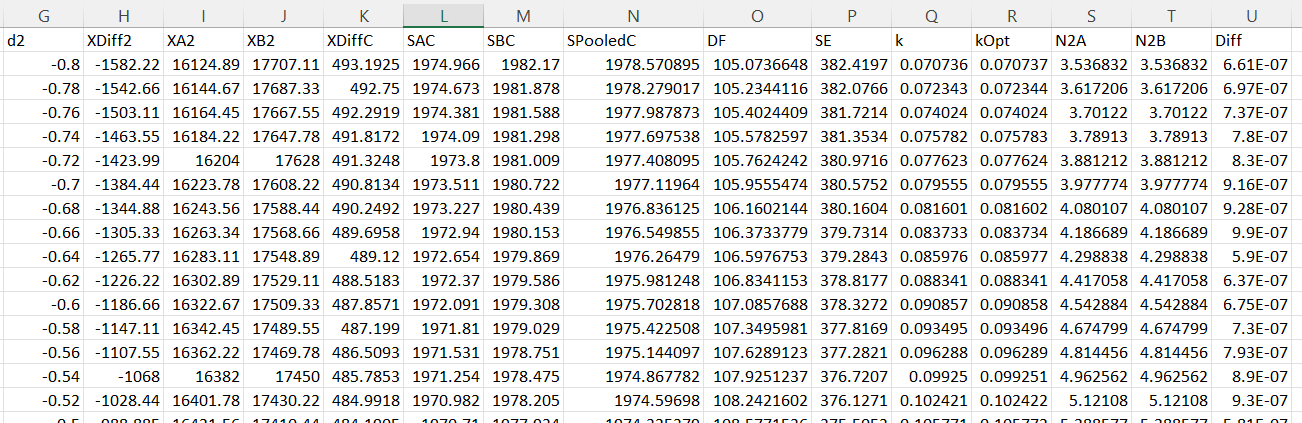
The two-sample test works in a similar way to the one-sample test, though the optimization procedure is more complex. The data consist of two independent samples. The settings are similar to the one-sample test, but both samples are included in the calculations. The settings and the data for the two-sample tests are given in Figure 2 and the output columns are given in Figure 3.

Figure 2: Two Sample Macro Worksheet Input

Table

Description automatically generated with medium confidence

Figure 3: Two Sample Macro Worksheet Output Columns



Descriptions of input, formula, and output cells for the two-sample test are summarized in Table 2.

Table 2: Sheet Descriptions for Two-Sample Tests

|  |  |  |
| --- | --- | --- |
| **Component** | **Type** | **Description** |
| D(0) | Input | The hypothesized D0 for the statistical test. This is 0 when testing for the equality of the means. |
| Alpha | Input | The Alpha (α) for the statistical test. As the algorithm only checks in one direction to either make a non-significant result significant or vice versa, for two tailed tests the value of α should be divided by two. |
| IsRight | Input | If TRUE, search in the right tail and if FALSE then search in the left tail. |
| zcrit | Formula | The critical value for a t sample two test given the “Alpha” and “IsRight” parameters defined above. |
| tcritStudent | Formula | The critical value for a two sample Student’s (equal variance) t test given the “Alpha” and “IsRight” parameters defined above, with the value of n calculated from the data given in column D. |
| tcritWelch | Formula | The critical value for a two sample Welch’s (ueequal variance) t test given the “Alpha” and “IsRight” parameters defined above, with the value of n calculated from the data given in column D. |
| xBarA | Formula | The sample mean for the group 1 data in column D. |
| sA | Formula | The sample standard deviation for the group 1 data in column D. |
| nA | Formula | The sample size for the group 1 data in column D. |
| XBarB, sB, nB | Formula | As above, but for the second group, group B in column E. |
| spooled | Formula | The pooled standard deviation for groups A and B (divided by nA + nB -2). |
| sML | Formula | As above, but the maximum likelihood estimate, divided by (divided by nA + nB). |
| Cohen’s d | Formula | The effect size of the difference between the means divided by sML. |
| Glass’s g | Formula | The effect size of the difference between the means divided by spooled. |
| z/tWelch | Formula | The value of the z statistic and the Welch’s t statistic (same formula). |
| tStudent | Formula | The value of Student’s t statistic |
| IsSignifz | Formula | TRUE if the z test is significant given the values of  “zcrit” and “IsRight”. FALSE otherwise. |
| IsSigniftStudent | Formula | TRUE if the Student’s t test is significant given the values of  “tcrit” and “IsRight”. FALSE otherwise. |
| IsSigniftWelch | Formula | TRUE if the Welch’s t test is significant given the values of  “tcrit” and “IsRight”. FALSE otherwise. |
| sMult | Input | The multiplier for the standard deviations in the WCRT samples, defaults to 1, i.e., same standard deviation as data sample. |
| s2A, s2B | Formula | The standard deviations of the WCRT samples, which are “sA” and “Sb” multiplied by “sMult”. |
| S2Pooled | Formula | The pooled standard deviation for the WCRT sample (assuming sample sizes in proportion to the data sample). |
| Min d2 | Input | The minimum WCRT standard effect size to be tested. |
| Max d2 | Input | The maximum WCRT standard effect size to be tested. |
| Increment | Input | The increment in the WCRT effect size, moving from Min d2 to Max d2. |
| Converge | Input | The convergence criteria for the fixed-point algorithm (the smaller, the more accurate). Defaults to 1.00E-08. |
| OutCol | Input | The column where the output data starts. |
| Run z | Button | Uses a gradient search algorithm to calculate the number of items required to negate the result of the statistical test for the effect sizes defined by Min d2, Max d2, and Increment. |
| Run Student’s t | Button | As above, but for the Student’s t-test. |
| Run Welch’s t | Button | As above, but for the Welch’s t-test. |
| XA, XB | Data | The columns containing the sample data. |
| d2 | Output | The effect size for the WCRT data. |
| XDifff2 | Output | The difference between means, given the effect size “d2” and standard deviations s2A and s2B. |
| XDiffC | Output | The combined difference between means for both the data samples and the WCRT data. |
| SAC, SBC | Output | The combined standard deviations for both the data samples and the WCRT data. |
| SPooledC | Output | Pooling the standard deviations for the two data samples. |
| DF | Output | The degrees of freedom (for t tests only). |
| SE | Output | The overall standard error for the combined data and WCRT samples. |
| k, kOpt | Output | Gradient descent intermediate criteria. |
| N2A, N2B | Output | The values of N in the WCRT sample required to negate the result of the statistical technique for an effect size of “d2”. It is assumed that the proportions do not change, i.e., N1A/N1B=N2A/N2B. |
| Diff | Diff | The sum of the absolute value of “N2A-N2AOpt” + “N2B-N2BOpt”.. The algorithm converges when this is below the value in “Converge”. |

Correlation Test

The correlation test works in a similar manner to the one-sample and two sample independent sample t tests. However, there are several differences between the correlation test and the previously described tests.

1. The data are dependent or paired. Typically, the measurements are taken across and individual subject.
2. The test is a z test, where z is defined by a transform from a correlation.
3. Here, the effect size is the actual correlation r, which is standardized between -1 and 1.

The worksheet for correlations is given in Figure 4.

Figure 4: Correlation Macro Worksheet

Graphical user interface, application, table, Excel

Description automatically generated

The associated descriptions of input, formula, and output cells for the correlation test are summarized in Table 3.

Table 3: Sheet Descriptions for Correlation Test

|  |  |  |
| --- | --- | --- |
| **Component** | **Type** | **Description** |
| Alpha | Input | The Alpha (α) for the statistical test. As the algorithm only checks in one direction to either make a non-significant result significant or vice versa, for two tailed tests the value of α should be divided by two. |
| IsRight | Input | If TRUE, search in the right tail and if FALSE then search in the left tail. |
| zcrit | Formula | The critical value for a single sample z test given the “Alpha” and “IsRight” parameters defined above. |
| tcrit | Formula | The critical value for a single sample t test given the “Alpha” and “IsRight” parameters defined above, with the value of n calculated from the data given in column D. |
| n1 | Formula | The sample size for the data in columns D and E. |
| Sum X | Formula | The sample sum for the X data in column D. |
| YBar | Formula | The sample mean for the X data in column D. |
| Sum X^2 | Formula | The sample sum for the square of the X data in column D. |
| Sum Y, YBar, Sum Y^2 | Formula | As above, but for the Y data in column E. |
| Sum XY | Formula | The sum of X\*Y. |
| SSxx, SSyy, SSxy | Formula | The calculated sum of squares values for the data. |
| Corr | Formula | The Pearson correlation calculated from the sum of squares values. |
| ztrans | Formula | The value of “Corr” transformed onto a z scale using in inverse hyperbolic tangent. |
| ZSample | Formula | The sample statistic for z, calculated as “ztrans” divided by its standard error. |
| IsSignifz | Formula | TRUE if the test is significant given the values of  “zcrit” and “IsRight”. FALSE otherwise. |
| Min r2 | Input | The minimum WCRT standard correlation effect size to be tested. |
| Max r2 | Input | The maximum WCRT standard correlation effect size to be tested. |
| Increment | Input | The increment in the WCRT effect size, moving from Min r2 to Max r2. |
| Converge | Input | The convergence criteria for the fixed-point algorithm (the smaller, the more accurate). Defaults to 1.00E-08. |
| OutCol | Input | The column where the output data starts. |
| Run z | Button | Uses a fixed-point algorithm to calculate the number of items required to negate the result of the statistical test for the effect sizes defined by Min d2, Max d2, and Increment. |
| X (named) | Data | The sample data for X in column D. |
| Y (named) | Data | The sample data for Y in column E. |
| r2 | Output | The effect size for the WCRT data. |
| ztrans2 | Output | The value of “r2” transformed onto a z scale using in inverse hyperbolic tangent. |
| zc | Output | The combined weighted correlation. |
| N2 | Output | The N calculated by the gradient descent algorithm required for the WCRT sample to reverse the result of the statistical test. |
| Z | Output | The final Z value for the combined data. N.B. This is on the boundary of significance and should be the same for each row. |

Other Sheets

The other worksheets on the spreadsheet are as follows:

* **PaperSummatedData:** The summated rating scales used to calculate the correlations in the Worst Case Resistance Testing paper.
* **CorrelationSummary:** Results for each of pair of scales in PaperSummatedData, for each possible WCRT nonresponse effect size.
* **Examplencurves:** Some example n curves. The final Worst Case Resistance Testing n curves were created in R.