Package ‘psychmeta’

April 9, 2020

Type Package
Title Psychometric Meta-Analysis Toolkit
Version 2.3.7
Date 2020-04-09

BugReports https://github.com/psychmeta/psychmeta/issues

Description
Tools for computing bare-bones and psychometric meta-analyses and for generating psychometric data for use in meta-analysis simulations. Supports bare-bones, individual-correction, and artifact-distribution methods for meta-analyzing correlations and d values. Includes tools for converting effect sizes, computing sporadic artifact corrections, reshaping meta-analytic databases, computing multivariate corrections for range variation, and more. Bugs can be reported to <https://github.com/psychmeta/psychmeta/issues> or <issues@psychmeta.com>.

License GPL (>= 3)
Depends R (>= 3.4.0)
Encoding UTF-8
LazyData true

VignetteBuilder knitr

Imports dplyr, stats, methods, MASS, boot, mvtnorm, tibble, reshape2, ggplot2, metafor, nor1mix, progress, tidyr (>= 1.0.0), stringi, stringr, rlang, curl, purrr, data.table, cli, crayon

Suggests bib2df, rmarkdown, knitr

RooxygenNote 7.1.0

NeedsCompilation no

Author Jeffrey A. Dahlke [aut, cre], Brenton M. Wiernik [aut], Michael T. Brannick [ctb] (Testing), Jack Kostal [ctb] (Code for reshape_mat2dat function), Sean Potter [ctb] (Testing; Code for cumulative and leave1out plots), John Sakaluk [ctb] (Code for funnel and forest plots), Yuejia (Mandy) Teng [ctb] (Testing)

Maintainer Jeffrey A. Dahlke <jdahlke@humrro.org>
Repository: CRAN
Date/Publication: 2020-04-09 15:50:02 UTC

R topics documented:

- psychmeta-package ........................................ 4
- .ma_r_order2 ............................................. 7
- .tau_squared_m_solver ..................................... 7
- .tau_squared_r_solver ..................................... 8
- adjust_n_d .................................................. 9
- adjust_n_r .................................................. 10
- anova.ma_psychmeta ...................................... 11
- composite_d_matrix ....................................... 12
- composite_d_scalar ...................................... 13
- composite_rel_matrix .................................... 14
- composite_rel_scalar .................................... 15
- composite_r_matrix ....................................... 16
- composite_r_scalar ...................................... 17
- composite_u_matrix ....................................... 19
- composite_u_scalar ...................................... 20
- compute_alpha ............................................ 21
- compute_dmod ............................................. 21
- compute_dmod_npar ....................................... 24
- compute_dmod_par ........................................ 27
- conf.limits.nc.chisq ..................................... 29
- confidence .................................................. 31
- confidence_r ............................................... 32
- confint ...................................................... 32
- control_intercor ......................................... 33
- control_psychmeta ....................................... 35
- convert_es ................................................. 38
- convert_ma ................................................ 40
- correct_d ................................................... 41
- correct_d_bias ............................................. 44
- correct_glass_bias ....................................... 45
- correct_matrix_mvrr ...................................... 46
- correct_means_mvrr ...................................... 47
- correct_r .................................................... 48
- correct_r_bias ............................................. 51
- correct_r_coarseness .................................... 52
- correct_r_dich ............................................. 54
- correct_r_split ............................................ 55
- create_ad ................................................... 56
- create_ad_group .......................................... 61
- create_ad_tibble ......................................... 63
- credibility ................................................. 67
- data_d_bb_multi ......................................... 68
<table>
<thead>
<tr>
<th>R topics documented:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>data_d_meas_multi</td>
<td>69</td>
</tr>
<tr>
<td>data_r_bvdr</td>
<td>69</td>
</tr>
<tr>
<td>data_r_bvrr</td>
<td>70</td>
</tr>
<tr>
<td>data_r_gonzalezmu_2014</td>
<td>70</td>
</tr>
<tr>
<td>data_r_mcdaniel_1994</td>
<td>71</td>
</tr>
<tr>
<td>data_r_mcleod_2007</td>
<td>71</td>
</tr>
<tr>
<td>data_r_meas</td>
<td>72</td>
</tr>
<tr>
<td>data_r_meas_multi</td>
<td>72</td>
</tr>
<tr>
<td>data_r_oh_2009</td>
<td>73</td>
</tr>
<tr>
<td>data_r_roth_2015</td>
<td>73</td>
</tr>
<tr>
<td>data_r_uvdrr</td>
<td>74</td>
</tr>
<tr>
<td>data_r_uvirr</td>
<td>74</td>
</tr>
<tr>
<td>estimate_artifacts</td>
<td>75</td>
</tr>
<tr>
<td>estimate_length_sb</td>
<td>79</td>
</tr>
<tr>
<td>estimate_prod</td>
<td>80</td>
</tr>
<tr>
<td>estimate_q_dist</td>
<td>82</td>
</tr>
<tr>
<td>estimate_rel_dist</td>
<td>82</td>
</tr>
<tr>
<td>estimate_rel_sb</td>
<td>83</td>
</tr>
<tr>
<td>estimate_u</td>
<td>84</td>
</tr>
<tr>
<td>estimate_var_artifacts</td>
<td>86</td>
</tr>
<tr>
<td>estimate_var_rho_int</td>
<td>96</td>
</tr>
<tr>
<td>estimate_var_rho_tsa</td>
<td>98</td>
</tr>
<tr>
<td>estimate_var_tsa</td>
<td>107</td>
</tr>
<tr>
<td>filter_ma</td>
<td>111</td>
</tr>
<tr>
<td>format_num</td>
<td>112</td>
</tr>
<tr>
<td>generate_bib</td>
<td>114</td>
</tr>
<tr>
<td>generate_directory</td>
<td>116</td>
</tr>
<tr>
<td>get_stuff</td>
<td>116</td>
</tr>
<tr>
<td>heterogeneity</td>
<td>122</td>
</tr>
<tr>
<td>limits_tau</td>
<td>125</td>
</tr>
<tr>
<td>limits_tau2</td>
<td>126</td>
</tr>
<tr>
<td>lm_mat</td>
<td>127</td>
</tr>
<tr>
<td>ma_d</td>
<td>129</td>
</tr>
<tr>
<td>ma_d_order2</td>
<td>142</td>
</tr>
<tr>
<td>ma_generic</td>
<td>144</td>
</tr>
<tr>
<td>ma_r</td>
<td>145</td>
</tr>
<tr>
<td>ma_r_order2</td>
<td>163</td>
</tr>
<tr>
<td>merge_simdat_d</td>
<td>165</td>
</tr>
<tr>
<td>merge_simdat_r</td>
<td>166</td>
</tr>
<tr>
<td>metabulate</td>
<td>166</td>
</tr>
<tr>
<td>metabulate_rmd_helper</td>
<td>170</td>
</tr>
<tr>
<td>metareg</td>
<td>172</td>
</tr>
<tr>
<td>mix_dist</td>
<td>173</td>
</tr>
<tr>
<td>mix_matrix</td>
<td>175</td>
</tr>
<tr>
<td>mix_r_2group</td>
<td>176</td>
</tr>
<tr>
<td>plot_forest</td>
<td>177</td>
</tr>
<tr>
<td>plot_funnel</td>
<td>178</td>
</tr>
<tr>
<td>predict</td>
<td>181</td>
</tr>
</tbody>
</table>
psychmeta-package

psychmeta: Psychometric meta-analysis toolkit

Description

Overview of the psychmeta package.
psychmeta-package

Details

The psychmeta package provides tools for computing bare-bones and psychometric meta-analyses and for generating psychometric data for use in meta-analysis simulations. Currently, psychmeta supports bare-bones, individual-correction, and artifact-distribution methods for meta-analyzing correlations and $d$ values. Please refer to the overview tutorial vignette for an introduction to psychmeta’s functions and workflows.

Running a meta-analysis

The main functions for conducting meta-analyses in psychmeta are ma_r for correlations and ma_d for $d$ values. These functions take meta-analytic dataframes including effect sizes and sample sizes (and, optionally, study labels, moderators, construct and measure labels, and psychometric artifact information) and return the full results of psychometric meta-analyses for all of the specified variable pairs. Examples of correctly formatted meta-analytic datasets for ma functions are data_r_roth_2015, data_r_gonzalezmule_2014, and data_r_mcdaniel_1994. Individual parts of the meta-analysis process can also be run separately; these functions are described in detail below.

Preparing a database for meta-analysis

The convert_es function can be used to convert a variety of effect sizes to either correlations or $d$ values. Sporadic psychometric artifacts, such as artificial dichotomization or uneven splits for a truly dichotomous variable, can be individually corrected using correct_r and correct_d. These functions can also be used to compute confidence intervals for observed, converted, and corrected effect sizes. ‘Wide’ meta-analytic coding sheets can be reformatted to the ‘long’ data frames used by psychmeta with reshape_wide2long. A correlation matrix and accompanying vectors of information can be similarly reformatted using reshape_mat2dat.

Meta-analytic models

psychmeta can compute barebones meta-analyses (no corrections for psychometric artifacts), as well as models correcting for measurement error in one or both variables, univariate direct (Case II) range restriction, univariate indirect (Case IV) range restriction, bivariate direct range restriction, bivariate indirect (Case V) range restriction, and multivariate range restriction. Artifacts can be corrected individually or using artifact distributions. Artifact distribution corrections can be applied using either Schmidt and Hunter’s (2015) interactive method or Taylor series approximation models. Meta-analyses can be computed using various weights, including sample size (default for correlations), inverse variance (computed using either sample or mean effect size; error based on mean effect size is the default for $d$ values), and weight methods imported from metafor.

Preparing artifact distributions meta-analyses

For individual-corrections meta-analyses, reliability and range restriction ($u$) values should be supplied in the same data frame as the effect sizes and sample sizes. Missing artifact data can be imputed using either bootstrap or other imputation methods. For artifact distribution meta-analyses, artifact distributions can be created automatically by ma_r or ma_d or manually by the create_ad family of functions.
Moderator analyses

Subgroup moderator analyses are run by supplying a moderator matrix to the `ma_r` or `ma_d` families of functions. Both simple and fully hierarchical moderation can be computed. Subgroup moderator analysis results are shown by passing an `ma_obj` to `print()`. Meta-regression analyses can be run using `metareg`.

Reporting results and supplemental analyses

Meta-analysis results can be viewed by passing an `ma` object to `print()`. Bootstrap confidence intervals, leave one out analyses, and other sensitivity analyses are available in `sensitivity`. Supplemental heterogeneity statistics (e.g., $Q$, $I^2$) can be computed using `heterogeneity`. Meta-analytic results can be converted between the $r$ and $d$ metrics using `convert_ma`. Each `ma_obj` contains a `metafor` `escalc` object in `ma$...$escalc` that can be passed to `metafor`'s functions for plotting, publication/availability bias, and other supplemental analyses. Second-order meta-analyses of correlations can be computed using `ma_r_order2`. Example second-order meta-analysis datasets from Schmidt and Oh (2013) are available. Tables of meta-analytic results can be written as rich text files using the `metabulate` function, which exports near publication-quality tables that will typically require only minor customization by the user.

Simulating psychometric meta-analyses

`psychmeta` can be used to run Monte Carlo simulations for different meta-analytic models. `simulate_r_sample` and `simulate_d_sample` simulate samples of correlations and $d$ values, respectively, with measurement error and/or range restriction artifacts. `simulate_r_database` and `simulate_d_database` can be used to simulate full meta-analytic databases of sample correlations and $d$ values, respectively, with artifacts. Example datasets fitting different meta-analytic models simulated using these functions are available (`data_r_meas`, `data_r_uvdrr`, `data_r_uvirr`, `data_r_bvdr`, `data_r_bvirr`, `data_r_meas_multi`, and `data_d_meas_multi`). Additional simulation functions are also available.

Author(s)

**Maintainer**: Jeffrey A. Dahlke <jdahlke@humrro.org>

Authors:

- Brenton M. Wiernik <brenton@psychmeta.com>

Other contributors:

- Michael T. Brannick (Testing) [contributor]
- Jack Kostal (Code for reshape_mat2dat function) [contributor]
- Sean Potter (Testing; Code for cumulative and leave1out plots) [contributor]
- John Sakaluk (Code for funnel and forest plots) [contributor]
- Yuejia (Mandy) Teng (Testing) [contributor]
See Also

Useful links:

- Report bugs at https://github.com/psychmeta/psychmeta/issues

---

.ma_r_order2

*Internal function for computing individual-correction meta-analyses of correlations*

---

**Description**

Internal function for computing individual-correction meta-analyses of correlations

**Usage**

```r
.ma_r_order2(data, type = "all", run_lean = FALSE, ma_arg_list)
```

**Arguments**

- **data**
  - Data frame of individual-correction information.

- **type**
  - Type of correlation to be meta-analyzed: "ts" for true score, "vgx" for validity generalization with "X" as the predictor, "vgy" for validity generalization with "X" as the predictor, and "all" for the complete set of results.

- **run_lean**
  - If TRUE, the meta-analysis will not generate a data object. Meant to speed up bootstrap analyses that do not require supplemental output.

- **ma_arg_list**
  - List of arguments to be used in the meta-analysis function.

**Value**

A meta-analytic table and a data frame.

---

.tau_squared_m_solver

*tau_m_squared Solver*

---

**Description**

Function to solve for tau_m_squared (outlier-robust estimator of tau_squared based on absolute deviations from median)

**Usage**

```r
.tau_squared_m_solver(Q_m, wi, k)
```
Arguments

- **Q_m**
  - The Q_r statistic.

- **wi**
  - Vector of inverse within-study sampling variances.

- **k**
  - The number of effect sizes included in the meta-analysis.

Value

- **tau_r_squared**

Author(s)

- Lifeng Lin and Haitao Chu

Description

Function to solve for tau_r_squared (outlier-robust estimator of tau_squared based on absolute deviations from mean)

Usage

```
.tau_squared_r_solver(Q_r, wi)
```

Arguments

- **Q_r**
  - The Q_r statistic.

- **wi**
  - Vector of inverse within-study sampling variances.

Value

- **tau_r_squared**

Author(s)

- Lifeng Lin and Haitao Chu
adjust_n_d

Adjusted sample size for a non-Cohen d value for use in a meta-analysis of Cohen’s d values

Description

This function is used to convert a non-Cohen d value (e.g., Glass’ \( \Delta \)) to a Cohen’s d value by identifying the sample size of a Cohen’s d that has the same standard error as the non-Cohen d. This function permits users to account for the influence of sporadic corrections on the sampling variance of d prior to use in a meta-analysis.

Usage

\[
\text{adjust_n_d}(d, \text{var_e}, p = \text{NA})
\]

Arguments

- \( d \): Vector of non-Cohen d standardized mean differences.
- \( \text{var_e} \): Vector of error variances of standardized mean differences.
- \( p \): Proportion of participants in a study belonging to one of the two groups being contrasted.

Details

\[
n_{\text{adjusted}} = \frac{d^2 \rho(1 - \rho) + 2}{2\rho(1 - \rho)\text{var}_e}
\]

Value

A vector of adjusted sample sizes.

References


Examples

\[
\text{adjust_n_d}(d = 1, \text{var_e} = .03, p = \text{NA})
\]
adjust_n_r

Adjusted sample size for a non-Pearson correlation coefficient for use in a meta-analysis of Pearson correlations

Description

This function is used to compute the adjusted sample size of a non-Pearson correlation (e.g., a tetrachoric correlation) based on the correlation and its estimated error variance. This function allows users to adjust the sample size of a correlation corrected for sporadic artifacts (e.g., unequal splits of dichotomous variables, artificial dichotomization of continuous variables) prior to use in a meta-analysis.

Usage

adjust_n_r(r, var_e)

Arguments

r Vector of correlations.

var_e Vector of error variances.

Details

The adjusted sample size is computed as:

\[ n_{\text{adjusted}} = \frac{(r^2 - 1)^2 + \text{var}_e}{\text{var}_e} \]

Value

A vector of adjusted sample sizes.

References


Examples

adjust_n_r(r = .3, var_e = .01)
Wald-type tests for moderators in psychmeta meta-analyses

Description

This function computes Wald-type pairwise comparisons for each level of categorical moderators for an `ma_psychmeta` object, as well as an omnibus one-way ANOVA test (equal variance not assumed).

Currently, samples across moderator levels are assumed to be independent.

Usage

```r
## S3 method for class 'ma_psychmeta'
anova(
  object,
  ..., analyses = "all",
  moderators = NULL,
  L = NULL,
  ma_obj2 = NULL,
  ma_method = c("bb", "ic", "ad"),
  correction_type = c("ts", "vgx", "vgy"),
  conf_level = NULL
)
```

Arguments

- `object` A `psychmeta` meta-analysis object.
- `...` Additional arguments.
- `analyses` Which analyses to test moderators for? Can be either "all" to test moderators for all meta-analyses in the object (default) or a list containing one or more of the arguments `construct`, `construct_pair`, `pair_id`, `k_min`, and `N_min`. See `filter_ma()` for details. Note that `analysis_id` should not be used. If `k_min` is not supplied, it is set to 2.
- `moderators` A character vector of moderators to test. If NULL, all categorical moderators are tested.
- `L` A named list with elements specifying set of linear contrasts for each variable in `moderators`. (Not yet implemented.)
- `ma_obj2` A second `psychmeta` meta-analysis object to compare to `object` (Not yet implemented.)
- `ma_method` Meta-analytic methods to be included. Valid options are: "bb", "ic", and "ad"
- `correction_type` Types of meta-analytic corrections to be included. Valid options are: "ts", "vgx", and "vgy"
- `conf_level` Confidence level to define the width of confidence intervals (defaults to value set when `object` was fit)
Value

An object of class anova.ma_psychmeta. A tibble with a row for each construct pair in object and a column for each moderator tested. Cells lists of contrasts tested.

Note

Currently, only simple (single) categorical moderators (one-way ANOVA) are supported.

Examples

```r
ma_obj <- ma_r(rxyi, n, construct_x = x_name, construct_y = y_name,
    moderators = moderator, data = data_r_meas_multi)
anova(ma_obj)
```

composite_d_matrix

Matrix formula to estimate the standardized mean difference associated with a weighted or unweighted composite variable

Description

This function is a wrapper for composite_r_matrix that converts $d$ values to correlations, computes the composite correlation implied by the $d$ values, and transforms the result back to the $d$ metric.

Usage

```r
composite_d_matrix(d_vec, r_mat, wt_vec, p = 0.5)
```

Arguments

- `d_vec`: Vector of standardized mean differences associated with variables in the composite to be formed.
- `r_mat`: Correlation matrix from which the composite is to be computed.
- `wt_vec`: Weights to be used in forming the composite (by default, all variables receive equal weight).
- `p`: The proportion of cases in one of the two groups used the compute the standardized mean differences.

Details

The composite $d$ value is computed by converting the vector of $d$ values to correlations, computing the composite correlation (see composite_r_matrix), and transforming that composite back into the $d$ metric. See "Details" of composite_r_matrix for the composite computations.

Value

The estimated standardized mean difference associated with the composite variable.
composite_d_scalar

Examples

```r
composite_d_matrix(d_vec = c(1, 1), r_mat = matrix(c(1, .7, .7, 1), 2, 2),
                   wt_vec = c(1, 1), p = .5)
```

composite_d_scalar Scalar formula to estimate the standardized mean difference associated with a composite variable

Description

This function estimates the $d$ value of a composite of $X$ variables, given the mean $d$ value of the individual $X$ values and the mean correlation among those variables.

Usage

```r
composite_d_scalar(
  mean_d,  # The mean standardized mean differences associated with variables in the composite to be formed.
  mean_intercor,  # The mean correlation among the variables in the composite.
  k_vars,  # The number of variables in the composite.
  p = 0.5,  # The proportion of cases in one of the two groups used to compute the standardized mean differences.
  partial_intercor = FALSE  # Logical scalar determining whether the intercor represents the partial (i.e., within-group) correlation among variables (TRUE) or the overall correlation between variables (FALSE).
)
```

Arguments

- `mean_d`: The mean standardized mean differences associated with variables in the composite to be formed.
- `mean_intercor`: The mean correlation among the variables in the composite.
- `k_vars`: The number of variables in the composite.
- `p`: The proportion of cases in one of the two groups used to compute the standardized mean differences.
- `partial_intercor`: Logical scalar determining whether the intercor represents the partial (i.e., within-group) correlation among variables (TRUE) or the overall correlation between variables (FALSE).

Details

There are two different methods available for computing such a composite, one that uses the partial intercorrelation among the $X$ variables (i.e., the average within-group correlation) and one that uses the overall correlation among the $X$ variables (i.e., the total or mixture correlation across groups).

If a partial correlation is provided for the interrelationships among variables, the following formula is used to estimate the composite $d$ value:

$$d_X = \frac{\tilde{d}_x k}{\sqrt{\tilde{\rho}_{xx} k^2 + (1 - \tilde{\rho}_{xx}) k}}$$
where $d_X$ is the composite $d$ value, $\bar{d}_{x_i}$ is the mean $d$ value, $\overline{\rho}_{x_i x_j}$ is the mean intercorrelation among the variables in the composite, and $k$ is the number of variables in the composite. Otherwise, the composite $d$ value is computed by converting the mean $d$ value to a correlation, computing the composite correlation (see `composite_r_scalar` for formula), and transforming that composite back into the $d$ metric.

**Value**

The estimated standardized mean difference associated with the composite variable.

**References**


**Examples**

```r
composite_d_scalar(mean_d = 1, mean_intercor = .7, k_vars = 2, p = .5)
```

**composite_rel_matrix**  
Matrix formula to estimate the reliability of a weighted or unweighted composite variable

**Description**

This function computes the reliability of a variable that is a weighted or unweighted composite of other variables.

**Usage**

```r
composite_rel_matrix(rel_vec, r_mat, sd_vec, wt_vec = rep(1, length(rel_vec)))
```

**Arguments**

- `rel_vec`  
  Vector of reliabilities associated with variables in the composite to be formed.

- `r_mat`  
  Correlation matrix from which the composite is to be computed.

- `sd_vec`  
  Vector of standard deviations associated with variables in the composite to be formed.

- `wt_vec`  
  Weights to be used in forming the composite (by default, all variables receive equal weight).
composite_rel_scalar

Details

This function treats measure-specific variance as reliable.

The Mosier composite formula is computed as:

\[ \rho_{XX} = \frac{w^T (r \circ s) + w^T Sw - w^T s}{w^T Sw} \]

where \( \rho_{XX} \) is a composite reliability estimate, \( r \) is a vector of reliability estimates, \( w \) is a vector of weights, \( S \) is a covariance matrix, and \( s \) is a vector of variances (i.e., the diagonal elements of \( S \)).

Value

The estimated reliability of the composite variable.

References


Examples

```r
composite_rel_matrix(rel_vec = c(.8, .8),
                     r_mat = matrix(c(1, .4, .4, 1), 2, 2),
                     sd_vec = c(1, 1))
```

```
composite_rel_scalar(mean_rel, mean_intercor, k_vars)
```

Description

This function computes the reliability of a variable that is a unit-weighted composite of other variables.

Usage

```r
composite_rel_scalar(mean_rel, mean_intercor, k_vars)
```

Arguments

- `mean_rel`: The mean reliability of variables in the composite.
- `mean_intercor`: The mean correlation among the variables in the composite.
- `k_vars`: The number of variables in the composite.
composite_r_matrix

Details

The Mosier composite formula is computed as:

$$\rho_{XX} = \bar{\rho}_{xixi} + k(k-1) \bar{\rho}_{xixj} / k(k-1) \bar{\rho}_{xixi}$$

where $\bar{\rho}_{xix}$ is the mean reliability of variables in the composite, $\bar{\rho}_{xixj}$ is the mean intercorrelation among variables in the composite, and $k$ is the number of variables in the composite.

Value

The estimated reliability of the composite variable.

References


Examples

```r
composite_rel_scalar(mean_rel = .8, mean_intercor = .4, k_vars = 2)
```

```r
composite_r_matrix Matrix formula to estimate the correlation between two weighted or unweighted composite variables
```

Description

This function computes the weighted (or unweighted, by default) composite correlation between a set of X variables and a set of Y variables.

Usage

```r
composite_r_matrix(
  r_mat,
  x_col,
  y_col,
  wt_vec_x = rep(1, length(x_col)),
  wt_vec_y = rep(1, length(y_col))
)
```
**Arguments**

- **r_mat**: Correlation matrix from which composite correlations are to be computed.
- **x_col**: Column indices of variables from 'r_mat' in the X composite (specify a single variable if Y is an observed variable rather than a composite).
- **y_col**: Column indices of variables from 'r_mat' in the Y composite (specify a single variable if Y is an observed variable rather than a composite).
- **wt_vec_x**: Weights to be used in forming the X composite (by default, all variables receive equal weight).
- **wt_vec_y**: Weights to be used in forming the Y composite (by default, all variables receive equal weight).

**Details**

This is computed as:

\[
\rho_{XY} = \frac{w_X^T R_{XY} w_Y}{\sqrt{(w_X^T R_{XX} w_X) (w_Y^T R_{YY} w_Y)}}
\]

where \(\rho_{XY}\) is the composite correlation, \(w\) is a vector of weights, and \(R\) is a correlation matrix. The subscripts of \(w\) and \(R\) indicate the variables indexed within the vector or matrix.

**Value**

A composite correlation

**References**


**Examples**

```r
composite_r_scalar(mean_rxy = .3, k_vars_x = 4, mean_intercor_x = .4)
R <- reshape_vec2mat(.4, order = 5)
R[-1,1] <- R[1,-1] <- .3
composite_r_matrix(r_mat = R, x_col = 2:5, y_col = 1)
```

**Description**

This function estimates the correlation between a set of X variables and a set of Y variables using a scalar formula.
Usage

```
composite_r_scalar(
    mean_rxy,
    k_vars_x = NULL,
    mean_intercor_x = NULL,
    k_vars_y = NULL,
    mean_intercor_y = NULL
)
```

Arguments

- `mean_rxy`: Mean correlation between sets of X and Y variables.
- `k_vars_x`: Number of X variables.
- `mean_intercor_x`: Mean correlation among X variables.
- `k_vars_y`: Number of Y variables.
- `mean_intercor_y`: Mean correlation among Y variables.

Details

The formula to estimate a correlation between one composite variable and one external variable is:

\[ \rho_{XY} = \frac{\bar{\rho}_{x,y}}{\sqrt{\frac{1}{k_x} + \frac{k_x - 1}{k_x} \bar{\rho}_{x,x}}} \]

and the formula to estimate the correlation between two composite variables is:

\[ \rho_{XY} = \frac{\bar{\rho}_{x,y}}{\sqrt{\frac{1}{k_x} + \frac{k_x - 1}{k_x} \bar{\rho}_{x,x}} \sqrt{\frac{1}{k_y} + \frac{k_y - 1}{k_y} \bar{\rho}_{y,y}}} \]

where \( \bar{\rho}_{x,y} \) and \( \bar{\rho}_{x,y} \) are mean correlations between the x variables and the y variable(s), \( \bar{\rho}_{x,x} \) is the mean correlation among x variables, \( \bar{\rho}_{y,y} \) is the mean correlation among y variables, \( k_x \) is the number of x variables, and \( k_y \) is the number of y variables.

Value

A vector of composite correlations

References


Examples

```r
## Composite correlation between 4 variables and an outside variable with which
## the four variables correlate .3 on average:
composite_r_scalar(mean_rxy = .3, k_vars_x = 4, mean_intercor_x = .4)

## Correlation between two composites:
composite_r_scalar(mean_rxy = .3, k_vars_x = 2, mean_intercor_x = .5,
k_vars_y = 2, mean_intercor_y = .2)
```

**composite_u_matrix**  
*Matrix formula to estimate the u ratio of a composite variable*

**Description**

This function estimates the u ratio of a composite variable when at least one matrix of correlations (restricted or unrestricted) among the variables is available.

**Usage**

```r
composite_u_matrix(
  ri_mat = NULL,
  ra_mat = NULL,
  u_vec,
  wt_vec = rep(1, length(u_vec)),
  sign_r_vec = 1
)
```

**Arguments**

- `ri_mat`: Range-restricted correlation matrix from which the composite is to be computed (if NULL, `ri_mat` is estimated from `ra_mat`).
- `ra_mat`: Unrestricted correlation matrix from which the composite is to be computed (if NULL, `ra_mat` is estimated from `ri_mat`).
- `u_vec`: Vector of u ratios associated with variables in the composite to be formed.
- `wt_vec`: Weights to be used in forming the composite (by default, all variables receive equal weight).
- `sign_r_vec`: The signs of the relationships between the variables in the composite and the variable by which range restriction was induced.

**Details**

This is computed as:

\[
u_{\text{composite}} = \sqrt{\frac{(w \odot u)^T R_i (w \odot u)}{w^T R_a w}}
\]

where \( u_{\text{composite}} \) is the composite u ratio, \( u \) is a vector of u ratios, \( R_i \) is a range-restricted correlation matrix, \( R_a \) is an unrestricted correlation matrix, and \( w \) is a vector of weights.


Value

The estimated $u$ ratio of the composite variable.

Examples

```r
composite_u_matrix(ri_mat = matrix(c(1, .3, .3, 1), 2, 2), u_vec = c(.8, .8))
```

---

**composite_u_scalar**  
Scalar formula to estimate the $u$ ratio of a composite variable

Description

This function provides an approximation of the $u$ ratio of a composite variable based on the $u$ ratios of the component variables, the mean restricted intercorrelation among those variables, and the mean unrestricted correlation among those variables. If only one of the mean intercorrelations is known, the other will be estimated using the bivariate indirect range-restriction formula. This tends to compute a conservative estimate of the $u$ ratio associated with a composite.

Usage

```r
composite_u_scalar(mean_ri = NULL, mean_ra = NULL, mean_u, k_vars)
```

Arguments

- `mean_ri`: The mean range-restricted correlation among variables in the composite.
- `mean_ra`: The mean unrestricted correlation among variables in the composite.
- `mean_u`: The mean $u$ ratio of variables in the composite.
- `k_vars`: The number of variables in the composite.

Details

This is computed as:

$$u_{\text{composite}} = \sqrt{\frac{\bar{\rho}_i \bar{u}^2 k (k - 1) + k \bar{u}^2}{\bar{\rho}_u k (k - 1) + k}}$$

where $u_{\text{composite}}$ is the composite $u$ ratio, $\bar{u}$ is the mean univariate $u$ ratio, $\bar{\rho}_i$ is the mean restricted correlation among variables, $\bar{\rho}_u$ is the mean unrestricted correlation among variables, and $k$ is the number of variables in the composite.

Value

The estimated $u$ ratio of the composite variable.

Examples

```r
composite_u_scalar(mean_ri = .3, mean_ra = .4, mean_u = .8, k_vars = 2)
```
**compute_alpha**

*Compute coefficient alpha*

**Description**

Compute coefficient alpha

**Usage**

```r
compute_alpha(sigma = NULL, data = NULL, standardized = FALSE, ...)
```

**Arguments**

- `sigma`: Covariance matrix (must be supplied if data argument is not supplied)
- `data`: Data matrix or data frame (must be supplied if sigma argument is not supplied)
- `standardized`: Logical scalar determining whether alpha should be computed from an unstandardized covariance matrix (TRUE) or a correlation matrix (FALSE).
- `...`: Additional arguments to be passed to `cov()` function.

**Value**

Coefficient alpha

**Examples**

```r
compute_alpha(sigma = reshape_vec2mat(cov = .4, order = 10))
```

**compute_dmod**

*Comprehensive d_Mod calculator*

**Description**

This is a general-purpose function to compute $d_{Mod}$ effect sizes from raw data and to perform bootstrapping. It subsumes the functionalities of the `compute_dmod_par` (for parametric computations) and `compute_dmod_npar` (for non-parametric computations) functions and automates the generation of regression equations and descriptive statistics for computing $d_{Mod}$ effect sizes. Please see documentation for `compute_dmod_par` and `compute_dmod_npar` for details about how the effect sizes are computed.
Usage

```
compute_dmod(
  data,
  group,
  predictors,
  criterion,
  referent_id,
  focal_id_vec = NULL,
  conf_level = 0.95,
  rescale_cdf = TRUE,
  parametric = TRUE,
  bootstrap = TRUE,
  boot_iter = 1000,
  stratify = FALSE,
  empirical_ci = FALSE,
  cross_validate_wts = FALSE
)
```

Arguments

data
  Data frame containing the data to be analyzed (if not a data frame, must be an object convertible to a data frame via the as.data.frame function). The data set must contain a criterion variable, at least one predictor variable, and a categorical variable that identifies the group to which each case (i.e., row) in the data set belongs.

group
  Name or column-index number of the variable that identifies group membership in the data set.

predictors
  Name(s) or column-index number(s) of the predictor variable(s) in the data set. No predictor can be a factor-type variable. If multiple predictors are specified, they will be combined into a regression-weighted composite that will be carried forward to compute $d_{Mod}$ effect sizes.

  • Note: If weights other than regression weights should be used to combine the predictors into a composite, the user must manually compute such a composite, include the composite in the data set, and identify the composite variable in predictors.

criterion
  Name or column-index number of the criterion variable in the data set. The criterion cannot be a factor-type variable.

referent_id
  Label used to identify the referent group in the group variable.

focal_id_vec
  Label(s) to identify the focal group(s) in the group variable. If NULL (the default), the specified referent group will be compared to all other groups.

conf_level
  Confidence level (between 0 and 1) to be used in generating confidence intervals. Default is .95

rescale_cdf
  Logical argument that indicates whether parametric $d_{Mod}$ results should be rescaled to account for using a cumulative density < 1 in the computations (TRUE; default) or not (FALSE).
compute_dmod

parametric Logical argument that indicates whether \(d_{Mod}\) should be computed using an assumed normal distribution (TRUE; default) or observed frequencies (FALSE).

bootstrap Logical argument that indicates whether \(d_{Mod}\) should be bootstrapped (TRUE; default) or not (FALSE).

boot_iter Number of bootstrap iterations to compute (default = 1000).

stratify Logical argument that indicates whether the random bootstrap sampling should be stratified (TRUE) or unstratified (FALSE; default).

empirical_ci Logical argument that indicates whether the bootstrapped confidence intervals should be computed from the observed empirical distributions (TRUE) or computed using bootstrapped means and standard errors via the normal-theory approach (FALSE).

cross_validate_wts Only relevant when multiple predictors are specified and bootstrapping is performed. Logical argument that indicates whether regression weights derived from the full sample should be used to combine predictors in the bootstrapped samples (TRUE) or if a new set of weights should be derived during each iteration of the bootstrapping procedure (FALSE; default).

Value

If bootstrapping is selected, the list will include:

- **point_estimate** A matrix of effect sizes (\(d_{Mod_{Signed}}\), \(d_{Mod_{Unsigned}}\), \(d_{Mod_{Under}}\), \(d_{Mod_{Over}}\)), proportions of under- and over-predicted criterion scores, minimum and maximum differences, and the scores associated with minimum and maximum differences. All of these values are computed using the full data set.

- **bootstrap_mean** A matrix of the same statistics as the point_estimate matrix, but the values in this matrix are the means of the results from bootstrapped samples.

- **bootstrap_se** A matrix of the same statistics as the point_estimate matrix, but the values in this matrix are bootstrapped standard errors (i.e., the standard deviations of the results from bootstrapped samples).

- **bootstrap_CI_Lo** A matrix of the same statistics as the point_estimate matrix, but the values in this matrix are the lower confidence bounds of the results from bootstrapped samples.

- **bootstrap_CI_Hi** A matrix of the same statistics as the point_estimate matrix, but the values in this matrix are the upper confidence bounds of the results from bootstrapped samples.

If no bootstrapping is performed, the output will be limited to the point_estimate matrix.

References


Examples

```r
# Generate some hypothetical data for a referent group and three focal groups:
set.seed(10)
```
Function for computing non-parametric d_Mod effect sizes for a single focal group

This function computes non-parametric \(d_{Mod}\) effect sizes from user-defined descriptive statistics and regression coefficients, using a distribution of observed scores as weights. This non-parametric function is best used when the assumption of normally distributed predictor scores is not reasonable and/or the distribution of scores observed in a sample is likely to represent the distribution of scores in the population of interest. If one has access to the full raw data set, the \(d_{Mod}\) function may be used as a wrapper to this function so that the regression equations and descriptive statistics can be computed automatically within the program.
Usage

compute_dmod_npar(
    referent_int,
    referent_slope,
    focal_int,
    focal_slope,
    focal_x,
    referent_sd_y
)

Arguments

referent_int  Referent group’s intercept.
referent_slope  Referent group’s slope.
focal_int  Focal group’s intercept.
focal_slope  Focal group’s slope.
focal_x  Focal group’s vector of predictor scores.
referent_sd_y  Referent group’s criterion standard deviation.

Details

The $d_{ModSigned}$ effect size (i.e., the average of differences in prediction over the range of predictor scores) is computed as

$$
d_{ModSigned} = \frac{\sum_{i=1}^{m} n_i [X_i (b_{11} - b_{12}) + b_{01} - b_{02}]}{SD_{Y1} \sum_{i=1}^{m} n_i},
$$

where

• $SD_{Y1}$ is the referent group’s criterion standard deviation;
• $m$ is the number of unique scores in the distribution of focal-group predictor scores;
• $X$ is the vector of unique focal-group predictor scores, indexed $i = 1$ through $m$;
• $X_i$ is the $i^{th}$ unique score value;
• $n$ is the vector of frequencies associated with the elements of $X$;
• $n_i$ is the number of cases with a score equal to $X_i$;
• $b_{11}$ and $b_{12}$ are the slopes of the regression of $Y$ on $X$ for the referent and focal groups, respectively; and
• $b_{01}$ and $b_{02}$ are the intercepts of the regression of $Y$ on $X$ for the referent and focal groups, respectively.

The $d_{ModUnder}$ and $d_{ModOver}$ effect sizes are computed using the same equation as $d_{ModSigned}$, but $d_{ModUnder}$ is the weighted average of all scores in the area of underprediction (i.e., the differences in prediction with negative signs) and $d_{ModOver}$ is the weighted average of all scores in the area of overprediction (i.e., the differences in prediction with negative signs).
The \( d_{\text{Mod}_{\text{unsigned}}} \) effect size (i.e., the average of absolute differences in prediction over the range of predictor scores) is computed as

\[
d_{\text{Mod}_{\text{unsigned}}} = \frac{\sum_{i=1}^{m} n_i |X_i (b_{11} - b_{12}) + b_01 - b_02|}{SD_Y \sum_{i=1}^{m} n_i}.
\]

The \( d_{\text{Min}} \) effect size (i.e., the smallest absolute difference in prediction observed over the range of predictor scores) is computed as

\[
d_{\text{Min}} = \frac{1}{SD_Y} \text{Min} \left[ |X (b_{11} - b_{12}) + b_01 - b_02| \right].
\]

The \( d_{\text{Max}} \) effect size (i.e., the largest absolute difference in prediction observed over the range of predictor scores) is computed as

\[
d_{\text{Max}} = \frac{1}{SD_Y} \text{Max} \left[ |X (b_{11} - b_{12}) + b_01 - b_02| \right].
\]

Note: When \( d_{\text{Min}} \) and \( d_{\text{Max}} \) are computed in this package, the output will display the signs of the differences (rather than the absolute values of the differences) to aid in interpretation.

Value

A vector of effect sizes (\( d_{\text{Mod}_{\text{Signed}}} \), \( d_{\text{Mod}_{\text{unsigned}}} \), \( d_{\text{Mod}_{\text{Under}}} \), \( d_{\text{Mod}_{\text{Over}}} \)), proportions of under- and over-predicted criterion scores, minimum and maximum differences (i.e., \( d_{\text{Mod}_{\text{Under}}} \) and \( d_{\text{Mod}_{\text{Over}}} \)), and the scores associated with minimum and maximum differences.

Examples

# Generate some hypothetical data for a referent group and three focal groups:
set.seed(10)
refDat <- MASS::mvrnorm(n = 1000, mu = c(.5, .2),
                        Sigma = matrix(c(1, .5, .5, 1), 2, 2), empirical = TRUE)
foc1Dat <- MASS::mvrnorm(n = 1000, mu = c(-.5, -.2),
                         Sigma = matrix(c(1, .5, .5, 1), 2, 2), empirical = TRUE)
foc2Dat <- MASS::mvrnorm(n = 1000, mu = c(0, 0),
                         Sigma = matrix(c(1, .3, .3, 1), 2, 2), empirical = TRUE)
foc3Dat <- MASS::mvrnorm(n = 1000, mu = c(-.5, -.2),
                         Sigma = matrix(c(1, .3, .3, 1), 2, 2), empirical = TRUE)
colnames(refDat) <- colnames(foc1Dat) <- colnames(foc2Dat) <- colnames(foc3Dat) <- c("X", "Y")

# Compute a regression model for each group:
refRegMod <- lm(Y ~ X, data.frame(refDat))$coef
foc1RegMod <- lm(Y ~ X, data.frame(foc1Dat))$coef
foc2RegMod <- lm(Y ~ X, data.frame(foc2Dat))$coef
foc3RegMod <- lm(Y ~ X, data.frame(foc3Dat))$coef

# Use the subgroup regression models to compute d_mod for each referent-focal pairing:
# Focal group #1:
compute_dmod_npar(referent_int = refRegMod[1], referent_slope = refRegMod[2],
                   focal_int = foc1RegMod[1], focal_slope = foc1RegMod[2],
                   focal_int = foc2RegMod[1], focal_slope = foc2RegMod[2],
                   focal_int = foc3RegMod[1], focal_slope = foc3RegMod[2],
                   focal_int = foc4RegMod[1], focal_slope = foc4RegMod[2],
                   focal_int = foc5RegMod[1], focal_slope = foc5RegMod[2],
                   focal_int = foc6RegMod[1], focal_slope = foc6RegMod[2],
                   focal_int = foc7RegMod[1], focal_slope = foc7RegMod[2],
                   focal_int = foc8RegMod[1], focal_slope = foc8RegMod[2],
                   focal_int = foc9RegMod[1], focal_slope = foc9RegMod[2],
                   focal_int = foc10RegMod[1], focal_slope = foc10RegMod[2])
Function for computing parametric d_{Mod} effect sizes for any number of focal groups

**Description**

This function computes $d_{Mod}$ effect sizes from user-defined descriptive statistics and regression coefficients. If one has access to a raw data set, the \texttt{dMod} function may be used as a wrapper to this function so that the regression equations and descriptive statistics can be computed automatically within the program.

**Usage**

```r
compute_dmod_par(
  referent_int, referent_slope,
  focal_int, focal_slope,
  focal_mean_x, focal_sd_x,
  referent_sd_y,
  focal_min_x, focal_max_x,
  focal_names = NULL,
  rescale_cdf = TRUE
)
```

**Arguments**

- `referent_int`: Referent group’s intercept.
- `referent_slope`: Referent group’s slope.
- `focal_int`: Focal groups’ intercepts.
- `focal_slope`: Focal groups’ slopes.
- `focal_mean_x`: Focal groups’ predictor-score means.
- `focal_sd_x`: Focal groups’ predictor-score standard deviations.
**referent_sd_y**  Referent group’s criterion standard deviation.

**focal_min_x**  Focal groups’ minimum predictor scores.

**focal_max_x**  Focal groups’ maximum predictor scores.

**focal_names**  Focal-group names. If NULL (the default), the focal groups will be given numeric labels ranging from 1 through the number of groups.

**rescale_cdf**  Logical argument that indicates whether parametric $d_{Mod}$ results should be rescaled to account for using a cumulative density < 1 in the computations (TRUE; default) or not (FALSE).

**Details**

The $d_{Mod_{Signed}}$ effect size (i.e., the average of differences in prediction over the range of predictor scores) is computed as

$$d_{Mod_{Signed}} = \frac{1}{SD_Y} \int f_2(X) [X (b_{11} - b_{12}) + b_{01} - b_{02}] dX,$$

where

- $SD_Y$ is the referent group’s criterion standard deviation;
- $f_2(X)$ is the normal-density function for the distribution of focal-group predictor scores;
- $b_{11}$ and $b_{12}$ are the slopes of the regression of $Y$ on $X$ for the referent and focal groups, respectively;
- $b_{01}$ and $b_{02}$ are the intercepts of the regression of $Y$ on $X$ for the referent and focal groups, respectively; and
- the integral spans all $X$ scores within the operational range of predictor scores for the focal group.

The $d_{Mod_{Under}}$ and $d_{Mod_{Over}}$ effect sizes are computed using the same equation as $d_{Mod_{Signed}}$, but $d_{Mod_{Under}}$ is the weighted average of all scores in the area of underprediction (i.e., the differences in prediction with negative signs) and $d_{Mod_{Over}}$ is the weighted average of all scores in the area of overprediction (i.e., the differences in prediction with negative signs).

The $d_{Mod_{Unsigned}}$ effect size (i.e., the average of absolute differences in prediction over the range of predictor scores) is computed as

$$d_{Mod_{Unsigned}} = \frac{1}{SD_Y} \int |X (b_{11} - b_{12}) + b_{01} - b_{02}| dX.$$

The $d_{Min}$ effect size (i.e., the smallest absolute difference in prediction observed over the range of predictor scores) is computed as

$$d_{Min} = \frac{1}{SD_Y} Min [|X (b_{11} - b_{12}) + b_{01} - b_{02}|].$$

The $d_{Max}$ effect size (i.e., the largest absolute difference in prediction observed over the range of predictor scores) is computed as

$$d_{Max} = \frac{1}{SD_Y} Max [|X (b_{11} - b_{12}) + b_{01} - b_{02}|].$$
Note: When $d_{Min}$ and $d_{Max}$ are computed in this package, the output will display the signs of the differences (rather than the absolute values of the differences) to aid in interpretation.

If $d_{Mod}$ effect sizes are to be rescaled to compensate for a cumulative density less than 1 (see the `rescale_cdf` argument), the result of each effect size involving integration will be divided by the ratio of the cumulative density of the observed range of scores (i.e., the range bounded by the `focal_min_x` and `focal_max_x` arguments) to the cumulative density of scores bounded by $-\infty$ and $\infty$.

Value

A matrix of effect sizes ($d_{ModSigned}$, $d_{ModUnsigned}$, $d_{ModUnder}$, $d_{ModOver}$), proportions of under- and over-predicted criterion scores, minimum and maximum differences (i.e., $d_{ModUnder}$ and $d_{ModOver}$), and the scores associated with minimum and maximum differences. Note that if the regression lines are parallel and infinite `focal_min_x` and `focal_max_x` values were specified, the extrema will be defined using the scores 3 focal-group SDs above and below the corresponding focal-group means.

References


Examples

```r
compute_dmod_par(referent_int = -.05, referent_slope = .5,
                 focal_int = c(.05, 0, -.05), focal_slope = c(.5, .3, .3),
                 focal_mean_x = c(-.5, 0, -.5), focal_sd_x = rep(1, 3),
                 referent_sd_y = 1,
                 focal_min_x = rep(-Inf, 3), focal_max_x = rep(Inf, 3),
                 focal_names = NULL, rescale_cdf = TRUE)
```

Description

Confidence limits for noncentral chi square parameters (function and documentation from package ’MBESS’ version 4.4.3) Function to determine the noncentral parameter that leads to the observed Chi.Square-value, so that a confidence interval for the population noncentral chi-square value can be formed.
Usage

conf.limits.nc.chisq(
  Chi.Square = NULL,
  conf.level = 0.95,
  df = NULL,
  alpha.lower = NULL,
  alpha.upper = NULL,
  tol = 1e-09,
  Jumping.Prop = 0.1
)

Arguments

Chi.Square  the observed chi-square value
conf.level  the desired degree of confidence for the interval
df  the degrees of freedom
alpha.lower  Type I error for the lower confidence limit
alpha.upper  Type I error for the upper confidence limit
tol  tolerance for iterative convergence
Jumping.Prop  Value used in the iterative scheme to determine the noncentral parameters necessary for confidence interval construction using noncentral chi square-distributions ($0 < \text{Jumping.Prop} < 1$)

Details

If the function fails (or if a function relying upon this function fails), adjust the Jumping.Prop (to a smaller value).

Value

- Lower.LimitValue of the distribution with Lower.Limit noncentral value that has at its specified quantile Chi.Square
- Prob.Less.LowerProportion of cases falling below Lower.Limit
- Upper.LimitValue of the distribution with Upper.Limit noncentral value that has at its specified quantile Chi.Square
- Prob.Greater.UpperProportion of cases falling above Upper.Limit

Author(s)

Ken Kelley (University of Notre Dame; <KKelley@ND.edu>), Keke Lai (University of California–Merced)
**confidence**

Construct a confidence interval

---

**Description**

Function to construct a confidence interval around an effect size or mean effect size.

**Usage**

```
confidence(
  mean,
  se = NULL,
  df = NULL,
  conf_level = 0.95,
  conf_method = c("t", "norm"),
  ...)
```

**Arguments**

- `mean` Mean effect size (if used in a meta-analysis) or observed effect size (if used on individual statistics).
- `se` Standard error of the statistic.
- `df` Degrees of freedom of the statistic (necessary if using the t distribution).
- `conf_level` Confidence level that defines the width of the confidence interval (default = .95).
- `conf_method` Distribution to be used to compute the width of confidence intervals. Available options are "t" for t distribution or "norm" for normal distribution.
- `...` Additional arguments

**Details**

\[ CI = mean_{es} \pm quantile \times SE_{es} \]

**Value**

A matrix of confidence intervals of the specified width.

**Examples**

```
confidence(mean = c(.3, .5), se = c(.15, .2), df = c(100, 200), conf_level = .95, conf_method = "t")
confidence(mean = c(.3, .5), se = c(.15, .2), conf_level = .95, conf_method = "norm")
```
confidence_r  

*Construct a confidence interval for correlations using Fisher’s z transformation*

**Description**

Construct a confidence interval for correlations using Fisher’s z transformation

**Usage**

`confidence_r(r, n, conf_level = 0.95)`

**Arguments**

- `r`: A vector of correlations
- `n`: A vector of sample sizes
- `conf_level`: Confidence level that defines the width of the confidence interval (default = .95).

**Value**

A confidence interval of the specified width (or matrix of confidence intervals)

**Examples**

`confidence_r(r = .3, n = 200, conf_level = .95)`

**confint**

*Confidence interval method for objects of classes deriving from "lm_mat"*

**Description**

Confidence interval method for objects of classes deriving from "lm_mat." Returns lower and upper bounds of confidence intervals for regression coefficients.

**Arguments**

- `object`: Matrix regression object.
- `parm`: A specification of which parameters are to be given confidence intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
- `level`: Confidence level
- `...`: further arguments passed to or from other methods.
control_intercor

Description
Control function to curate intercorrelations to be used in automatic compositing routine

Usage
control_intercor(
  rxyi = NULL,
  n = NULL,
  sample_id = NULL,
  construct_x = NULL,
  construct_y = NULL,
  construct_names = NULL,
  facet_x = NULL,
  facet_y = NULL,
  intercor_vec = NULL,
  intercor_scalar = 0.5,
  dx = NULL,
  dy = NULL,
  p = 0.5,
  partial_intercor = FALSE,
  data = NULL,
...
)

Arguments
rxyi Vector or column name of observed correlations.
n Vector or column name of sample sizes.
sample_id Vector of identification labels for samples/studies in the meta-analysis.
construct_x, construct_y Vector of construct names for constructs designated as "X" or "Y".
construct_names Vector of all construct names to be included in the meta-analysis.
facet_x, facet_y Vector of facet names for constructs designated as "X" or "Y".
intecor_vec Named vector of pre-specified intercorrelations among measures of constructs in the meta-analysis.
intecor_scalar Generic scalar intercorrelation that can stand in for unobserved or unspecified values.
dx, dy

d values corresponding to construct_x and construct_y. These values only need to be supplied for cases in which rxyi represents a correlation between two measures of the same construct.

p

Scalar or vector containing the proportions of group membership corresponding to the d values.

partial_intercor

For meta-analyses of d values only: Logical scalar, vector, or column corresponding to values in rxyi that determines whether the correlations are to be treated as within-group correlations (i.e., partial correlation controlling for group membership; TRUE) or not (FALSE; default). Note that this only converts correlation values from the rxyi argument - any values provided in the intercor_vec or intercor_scalar arguments must be total correlations or converted to total correlations using the mix_r_2group() function prior to running control_intercor.

data

Data frame containing columns whose names may be provided as arguments to vector arguments.

... Further arguments to be passed to functions called within the meta-analysis.

Value

A vector of intercorrelations

Examples

```r
## Create a dataset in which constructs correlate with themselves
rxyi <- seq(.1, .5, length.out = 27)
construct_x <- rep(rep(c("X", "Y", "Z"), 3), 3)
construct_y <- c(rep("X", 9), rep("Y", 9), rep("Z", 9))
dat <- data.frame(rxyi = rxyi,
                 construct_x = construct_x,
                 construct_y = construct_y,
                 stringsAsFactors = FALSE)
dat <- rbind(cbind(sample_id = "Sample 1", dat),
             cbind(sample_id = "Sample 2", dat),
             cbind(sample_id = "Sample 3", dat))

## Identify some constructs for which intercorrelations are not
## represented in the data object:
construct_names = c("U", "V", "W")

## Specify some externally determined intercorrelations among measures:
intercor_vec <- c(W = .4, X = .1)

## Specify a generic scalar intercorrelation that can stand in for missing values:
intercor_scalar <- .5

control_intercor(rxyi = rxyi, sample_id = sample_id,
                 construct_x = construct_x, construct_y = construct_y,
                 construct_names = construct_names,
                 intercor_vec = intercor_vec, intercor_scalar = intercor_scalar, data = dat)
```
control_psychmeta

Control for psychmeta meta-analyses

Description

Control for psychmeta meta-analyses

Usage

control_psychmeta(
  error_type = c("mean", "sample"),
  conf_level = 0.95,
  cred_level = 0.8,
  conf_method = c("t", "norm"),
  cred_method = c("t", "norm"),
  var_unbiased = TRUE,
  pairwise_ads = FALSE,
  moderated_ads = FALSE,
  residual_ads = TRUE,
  check_dependence = TRUE,
  collapse_method = c("composite", "average", "stop"),
  intercor = control_intercor(),
  clean_artifacts = TRUE,
  impute_artifacts = TRUE,
  impute_method = c("bootstrap_mod", "bootstrap_full", "simulate_mod", "simulate_full",
                   "wt_mean_mod", "wt_mean_full", "unwt_mean_mod", "unwt_mean_full", "replace.Unity",
                   "stop"),
  seed = 42,
  use_all_arts = TRUE,
  estimate_pa = FALSE,
  decimals = 2,
  hs_override = FALSE,
  ...
)

Arguments

- **error_type**: Method to be used to estimate error variances: "mean" uses the mean effect size to estimate error variances and "sample" uses the sample-specific effect sizes.
- **conf_level**: Confidence level to define the width of the confidence interval (default = .95).
- **cred_level**: Credibility level to define the width of the credibility interval (default = .80).
- **conf_method**: Distribution to be used to compute the width of confidence intervals. Available options are "t" for t distribution or "norm" for normal distribution.
- **cred_method**: Distribution to be used to compute the width of credibility intervals. Available options are "t" for t distribution or "norm" for normal distribution.
control_psychmeta

var_unbiased Logical scalar determining whether variances should be unbiased (TRUE) or maximum-likelihood (FALSE).

pairwise_ads Logical value that determines whether to compute artifact distributions in a construct-pair-wise fashion (TRUE) or separately by construct (FALSE, default).

moderated_ads Logical value that determines whether to compute artifact distributions separately for each moderator combination (TRUE) or for overall analyses only (FALSE, default).

residual_ads Logical argument that determines whether to use residualized variances (TRUE) or observed variances (FALSE) of artifact distributions to estimate sd_rho.

check_dependence Logical scalar that determines whether database should be checked for violations of independence (TRUE) or not (FALSE).

collapse_method Character argument that determines how to collapse dependent studies. Options are "composite" (default), "average," and "stop."

intercor The intercorrelation(s) among variables to be combined into a composite. Can be a scalar, a named vector with element named according to the names of constructs, or output from the control_intercor function. Default scalar value is 0.5.

clean_artifacts If TRUE, multiple instances of the same construct (or construct-measure pair, if measure is provided) in the database are compared and reconciled with each other in the case that any of the matching entries within a study have different artifact values. When impute_method is anything other than "stop", this method is always implemented to prevent discrepancies among imputed values.

impute_artifacts If TRUE, artifact imputation will be performed (see impute_method for imputation procedures). Default is FALSE for artifact-distribution meta-analyses and TRUE otherwise. When imputation is performed, clean_artifacts is treated as TRUE so as to resolve all discrepancies among artifact entries before and after imputation.

impute_method Method to use for imputing artifacts. Choices are:

- bootstrap_mod
  Select random values from the most specific moderator categories available (default).

- bootstrap_full
  Select random values from the full vector of artifacts.

- simulate_mod
  Generate random values from the distribution with the mean and variance of observed artifacts from the most specific moderator categories available. (uses rnorm for u ratios and rbeta for reliability values).

- simulate_full
  Generate random values from the distribution with the mean and variance of all observed artifacts (uses rnorm for u ratios and rbeta for reliability values).
control_psychmeta

- wt_mean_mod
  Replace missing values with the sample-size weighted mean of the distribution of artifacts from the most specific moderator categories available (not recommended).

- wt_mean_full
  Replace missing values with the sample-size weighted mean of the full distribution of artifacts (not recommended).

- unwt_mean_mod
  Replace missing values with the unweighted mean of the distribution of artifacts from the most specific moderator categories available (not recommended).

- unwt_mean_full
  Replace missing values with the unweighted mean of the full distribution of artifacts (not recommended).

- replace_unity
  Replace missing values with 1 (not recommended).

- stop
  Stop evaluations when missing artifacts are encountered.

If an imputation method ending in "mod" is selected but no moderators are provided, the "mod" suffix will internally be replaced with "full".

seed
Seed value to use for imputing artifacts in a reproducible way. Default value is 42.

use_all_arts
Logical scalar that determines whether artifact values from studies without valid effect sizes should be used in artifact distributions (TRUE; default) or not (FALSE).

estimate_pa
Logical scalar that determines whether the unrestricted subgroup proportions associated with univariate-range-restricted effect sizes should be estimated by rescaling the range-restricted subgroup proportions as a function of the range-restriction correction (TRUE) or not (FALSE; default).

decimals
Number of decimal places to which interactive artifact distributions should be rounded (default is 2 decimal places).

hs_override
When TRUE, this will override settings for wt_type (will set to "sample_size"), error_type (will set to "mean"), correct_bias (will set to TRUE), conf_method (will set to "norm"), cred_method (will set to "norm"), var_unbiased (will set to FALSE), residual_ads (will be set to FALSE), and use_all_arts (will set to FALSE).

... Further arguments to be passed to functions called within the meta-analysis.

Value
A list of control arguments in the package environment.

Examples
control_psychmeta()
convert_es

Convert effect sizes and compute confidence intervals

Description
This function converts a variety of effect sizes to either correlations or Cohen’s $d$ values. The function also computes and prints confidence intervals for the output effect sizes.

Usage
```r
convert_es(es, 
input_es = c("r", "d", "delta", "g", "t", "p.t", "F", "p.F", "chisq", "p.chisq", 
  "or", "lor", "Fisherz", "A", "auc", "cles"), 
output_es = c("r", "d", "A", "auc", "cles"), 
n1 = NULL, 
n2 = NULL, 
df1 = NULL, 
df2 = NULL, 
sd1 = NULL, 
sd2 = NULL, 
tails = 2, 
correct_bias = TRUE, 
conf_level = 0.95
)
```

Arguments
- `es` Vector of effect sizes to convert.
- `input_es` Scalar. Metric of input effect sizes. Currently supports correlations, Cohen’s $d$, independent samples $t$ values (or their $p$ values), two-group one-way ANOVA $F$ values (or their $p$ values), 1df $\chi^2$ values (or their $p$ values), odds ratios, log odds ratios, Fisher $z$, and the common language effect size (CLES, A, AUC).
- `output_es` Scalar. Metric of output effect sizes. Currently supports correlations, Cohen’s $d$ values, and common language effect sizes (CLES, A, AUC).
- `n1` Vector of total sample sizes or sample sizes of group 1 of the two groups being contrasted.
- `n2` Vector of sample sizes of group 2 of the two groups being contrasted.
- `df1` Vector of input test statistic degrees of freedom (for $t$ and $\chi^2$) or between-groups degree of freedom (for $F$).
- `df2` Vector of input test statistic within-group degrees of freedom (for $F$).
- `sd1` Vector of pooled (within-group) standard deviations or standard deviations of group 1 of the two groups being contrasted.
- `sd2` Vector of standard deviations of group 2 of the two groups being contrasted.
convert_es

tails Vector of the tails for \( p \) values when \( \text{input_es} = \text{"p.t"} \). Can be ‘2’ (default) or ‘1’.
correct_bias Logical argument that determines whether to correct output effect sizes and error-variance estimates for small-sample bias (TRUE) or not (FALSE) when computing confidence intervals.
conf_level Confidence level that defines the width of the confidence interval (default = .95).

Value

A \text{psychmeta} effect size \text{es} object containing:

meta_input A matrix of converted effect sizes and adjusted sample sizes for use in subsequent meta-analyses.
original_es The input data.
confidence The output data with computed confidence intervals (for printing).

Notes

To use converted effect sizes in a meta-analysis, add the values from \text{es}\$\text{meta_input} to your meta-analytic input data frame.

References


Examples

```r
## To convert a statistic to r or d metric:
convert_es(es = 1, input_es="d", output_es="r", n1=100)
convert_es(es = 1, input_es="d", output_es="r", n1=50, n2 = 50)
convert_es(es = .2, input_es="r", output_es="d", n1=100, n2=150)
convert_es(es = -1.3, input_es="t", output_es="r", n1 = 100, n2 = 140)
convert_es(es = 10.3, input_es="F", output_es="d", n1 = 100, n2 = 150)
convert_es(es = 1.3, input_es="chisq", output_es="r", n1 = 100, n2 = 100)
convert_es(es = .021, input_es="p.chisq", output_es="d", n1 = 100, n2 = 100)
convert_es(es = 4.37, input_es="or", output_es="r", n1=100, n2=100)
convert_es(es = 4.37, input_es="or", output_es="d", n1=100, n2=100)
convert_es(es = 1.47, input_es="lor", output_es="r", n1=100, n2=100)
convert_es(es = 1.47, input_es="lor", output_es="d", n1=100, n2=100)
```

```r
## To simply compute a confidence interval for r, d, or A:
convert_es(es = .3, input_es="r", output_es="r", n1=100)
convert_es(es = .8, input_es="d", output_es="d", n1=64, n2=36)
convert_es(es = .8, input_es="A", output_es="A", n1=64, n2=36)
```
convert_ma

Function to convert meta-analysis of correlations to d values or vice-versa

Description

Takes a meta-analysis class object of d values or correlations (classes r_as_r, d_as_d, r_as_d, and d_as_r; second-order meta-analyses are currently not supported) as an input and uses conversion formulas and Taylor series approximations to convert effect sizes and variance estimates, respectively.

Usage

convert_ma(ma_obj, ...)

convert_meta(ma_obj, ...)

Arguments

ma_obj A meta-analysis object of class r_as_r, d_as_d, r_as_d, or d_as_r

... Additional arguments.

Details

The formula used to convert correlations to d values is:

\[ d = r \frac{\sqrt{\frac{1}{p(1-p)}}}{\sqrt{1 - r^2}} \]

The formula used to convert d values to correlations is:

\[ r = \frac{d}{\sqrt{d^2 + \frac{1}{p(1-p)}}} \]

To approximate the variance of correlations from the variance of d values, the function computes:

\[ var_r \approx a_d^2 var_d \]

where \( a_d \) is the first partial derivative of the d-to-r transformation with respect to d:

\[ a_d = -\frac{1}{[d^2 p (1 - p) - 1] \sqrt{d^2 + \frac{1}{p - p^2}}} \]

To approximate the variance of d values from the variance of correlations, the function computes:

\[ var_d \approx a_r^2 var_r \]

where \( a_r \) is the first partial derivative of the r-to-d transformation with respect to r:

\[ a_r = -\frac{\sqrt{\frac{1}{p - p^2}}}{(1 - r^2)^{1.5}} \]
The function `correct_d()` is a wrapper for the `correct_r()` function to correct d values for statistical and psychometric artifacts.

**Value**
A meta-analysis converted to the d value metric (if ma_obj was a meta-analysis in the correlation metric) or converted to the correlation metric (if ma_obj was a meta-analysis in the d value metric).

**Usage**
```r
correct_d(
  correction = c("meas", "uvdrr_g", "uvdrr_y", "uvirr_g", "uvirr_y", "bvdrr", "bvirr"),
  d,
  ryy = 1,
  uy = 1,
  rGg = 1,
  pi = NULL,
  pa = NULL,
  uy_observed = TRUE,
  ryy_restricted = TRUE,
  ryy_type = "alpha",
  k_items_y = NA,
  sign_rgz = 1,
  sign_ryz = 1,
  n1 = NULL,
  n2 = NA,
  conf_level = 0.95,
  correct_bias = FALSE
)
```

**Arguments**
- `correction` Type of correction to be applied. Options are "meas", "uvdrr_g", "uvdrr_y", "uvirr_g", "uvirr_y", "bvdrr", "bvirr"
- `d` Vector of d values.
- `ryy` Vector of reliability coefficients for Y (the continuous variable).
- `uy` Vector of u ratios for Y (the continuous variable).
- `rGg` Vector of reliabilities for the group variable (i.e., the correlations between observed group membership and latent group membership).
- `pi` Proportion of cases in one of the groups in the observed data (not necessary if n1 and n2 reflect this proportionality).
Proportion of cases in one of the groups in the population.

Logical vector in which each entry specifies whether the corresponding uy value is an observed-score u ratio (TRUE) or a true-score u ratio. All entries are TRUE by default.

Logical vector in which each entry specifies whether the corresponding rxx value is an incumbent reliability (TRUE) or an applicant reliability. All entries are TRUE by default.

String vector identifying the types of reliability estimates supplied (e.g., "alpha", "retest", "interrater_r", "splithalf"). See the documentation for ma_r for a full list of acceptable reliability types.

Numeric vector identifying the number of items in each scale.

Vector of signs of the relationships between grouping variables and the selection mechanism.

Vector of signs of the relationships between Y variables and the selection mechanism.

Optional vector of sample sizes associated with group 1 (or the total sample size, if n2 is NULL).

Optional vector of sample sizes associated with group 2.

Confidence level to define the width of the confidence interval (default = .95).

Logical argument that determines whether to correct error-variance estimates for small-sample bias in correlations (TRUE) or not (FALSE). For sporadic corrections (e.g., in mixed artifact-distribution meta-analyses), this should be set to FALSE (the default).

Data frame(s) of observed d values (dgyi), operational range-restricted d values corrected for measurement error in Y only (dgpi), operational range-restricted d values corrected for measurement error in the grouping only (dGyi), and range-restricted true-score d values (dGpi), range-corrected observed-score d values (dgya), operational range-corrected d values corrected for measurement error in Y only (dgpa), operational range-corrected d values corrected for measurement error in the grouping only (dGya), and range-corrected true-score d values (dGpa).


Dahlke, J. A., & Wiernik, B. M. (2018). One of these artifacts is not like the others: Accounting for indirect range restriction in organizational and psychological research. Manuscript submitted for review.


Examples

```r
## Correction for measurement error only
correct_d(correction = "meas", d = .5, ryy = .8, uy = .7,
         rGg = .9, pi = .7, pa = .5)
correct_d(correction = "meas", d = .5, ryy = .8, uy = .7,
         rGg = .9, pi = NULL, pa = .5, n1 = 100, n2 = 200)

## Correction for direct range restriction in the continuous variable
correct_d(correction = "uvdrr_y", d = .5, ryy = .8, uy = .7,
         rGg = .9, pi = .7, pa = .5)
correct_d(correction = "uvdrr_y", d = .5, ryy = .8, uy = .7,
         rGg = .9, pi = NULL, pa = .5, n1 = 100, n2 = 200)

## Correction for direct range restriction in the grouping variable
correct_d(correction = "uvdrr_g", d = .5, ryy = .8, uy = .7,
         rGg = .9, pi = .7, pa = .5)
correct_d(correction = "uvdrr_g", d = .5, ryy = .8, uy = .7,
         rGg = .9, pi = NULL, pa = .5, n1 = 100, n2 = 200)

## Correction for indirect range restriction in the continuous variable
correct_d(correction = "uvdrr_y", d = .5, ryy = .8, uy = .7,
         rGg = .9, pi = .7, pa = .5)
correct_d(correction = "uvdrr_y", d = .5, ryy = .8, uy = .7,
         rGg = .9, pi = NULL, pa = .5, n1 = 100, n2 = 200)

## Correction for indirect range restriction in the grouping variable
correct_d(correction = "uvdrr_g", d = .5, ryy = .8, uy = .7,
         rGg = .9, pi = .7, pa = .5)
correct_d(correction = "uvdrr_g", d = .5, ryy = .8, uy = .7,
         rGg = .9, pi = NULL, pa = .5, n1 = 100, n2 = 200)

## Correction for direct range restriction in both variables
correct_d(correction = "bvdrr", d = .5, ryy = .8, uy = .7,
          rGg = .9, pi = .7, pa = .5)
correct_d(correction = "bvdrr", d = .5, ryy = .8, uy = .7,
          rGg = .9, pi = NULL, pa = .5, n1 = 100, n2 = 200)

## Correction for indirect range restriction in both variables
```
correct_d_bias

Description
Corrects a vector of Cohen’s d values for small-sample bias, as Cohen’s d has a slight positive bias. The bias-corrected d value is often called Hedges’s g.

Usage
correct_d_bias(d, n)

Arguments
d Vector of Cohen’s d values.
n Vector of sample sizes.

Details
The bias correction is:

\[ g = \frac{d_{\text{obs}} \times J}{J} \]

where

\[ J = \frac{\Gamma\left(\frac{n-2}{2}\right)}{\sqrt{\frac{n-2}{2} \times \Gamma\left(\frac{n-3}{2}\right)}} \]

and \( d_{\text{obs}} \) is the observed effect size, \( g = d_c \) is the corrected (unbiased) estimate, \( n \) is the total sample size, and \( \Gamma() \) is the gamma function.

Historically, using the gamma function was computationally intensive, so an approximation for \( J \) was used (Borenstein et al., 2009):

\[ J = 1 - 3/(4 \times (n - 2) - 1) \]

This approximation is no longer necessary with modern computers.

Value
Vector of g values (d values corrected for small-sample bias).

References
**correct_glass_bias**  
Correct for small-sample bias in Glass’ $\Delta$ values

**Usage**

```r
correct_glass_bias(delta, nc, ne, use_pooled_sd = rep(FALSE, length(delta)))
```

**Arguments**

- `delta`: Vector of Glass’ $\Delta$ values.
- `nc`: Vector of control-group sample sizes.
- `ne`: Vector of experimental-group sample sizes.
- `use_pooled_sd`: Logical vector determining whether the pooled standard deviation was used (TRUE) or not (FALSE; default).

**Details**

The bias correction is estimated as:

$$
\Delta_c = \Delta_{obs} \frac{\Gamma\left(\frac{n_{control} - 1}{2}\right)}{\Gamma\left(\frac{n_{control} - 2}{2}\right)}
$$

where $\Delta$ is the observed effect size, $\Delta_c$ is the corrected estimate of $\Delta$, $n_{control}$ is the control-group sample size, and $\Gamma()$ is the gamma function.

**Value**

Vector of d values corrected for small-sample bias.

**References**


**Examples**

```r
correct_glass_bias(delta = .3, nc = 30, ne = 30)
```
correct_matrix_mvrr      Multivariate select/correction for covariance matrices

Description
Correct (or select upon) a covariance matrix using the Pearson-Aitken-Lawley multivariate selection theorem.

Usage
correct_matrix_mvrr(
  Sigma_i,
  Sigma_xx_a,
  x_col,
  y_col = NULL,
  standardize = FALSE,
  var_names = NULL
)

Arguments
Sigma_i            The complete range-restricted (unrestricted) covariance matrix to be corrected (selected upon).
Sigma_xx_a         The matrix of unrestricted (range-restricted) covariances among of selection variables.
x_col              The row/column indices of the variables in Sigma_i that correspond, in order, to the variables in Sigma_xx_a.
y_col              Optional: The variables in Sigma_i not listed in x_col that are to be manipulated by the multivariate range-restriction formula.
standardize        Should the function’s output matrix be returned in standardized form (TRUE) or in unstandardized form (FALSE; the default).
var_names           Optional vector of names for the variables in Sigma_i, in order of appearance in the matrix.

Value
A matrix that has been manipulated by the multivariate range-restriction formula.

References

**correct_means_mvrr**  

**Examples**

```r
Sigma_i <- reshape_vec2mat(cov = .2, var = .8, order = 4)
Sigma_xx_a <- reshape_vec2mat(cov = .5, order = 2)
correct_matrix_mvrr(Sigma_i = Sigma_i, Sigma_xx_a = Sigma_xx_a, x_col = 1:2, standardize = TRUE)
```

---

**correct_means_mvrr**  
Multivariate select/correction for vectors of means

**Description**

Correct (or select upon) a vector of means using principles from the Pearson-Aitken-Lawley multivariate selection theorem.

**Usage**

```r
correct_means_mvrr(
  Sigma,
  means_i = rep(0, ncol(Sigma)),
  means_x_a,
  x_col,
  y_col = NULL,
  var_names = NULL
)
```

**Arguments**

- **Sigma**  
  The complete covariance matrix to be used to manipulate means: This matrix may be entirely unrestricted or entirely range restricted, as the regression weights estimated from this matrix are expected to be invariant to the effects of selection.

- **means_i**  
  The complete range-restricted (unrestricted) vector of means to be corrected (selected upon).

- **means_x_a**  
  The vector of unrestricted (range-restricted) means of selection variables

- **x_col**  
  The row/column indices of the variables in Sigma that correspond, in order, to the variables in means_x_a

- **y_col**  
  Optional: The variables in Sigma not listed in x_col that are to be manipulated by the multivariate range-restriction formula.

- **var_names**  
  Optional vector of names for the variables in Sigma, in order of appearance in the matrix.

**Value**

A vector of means that has been manipulated by the multivariate range-restriction formula.
References


Examples

```r
Sigma <- diag(.5, 4)
Sigma[lower.tri(Sigma)] <- c(.2, .3, .4, .3, .4, .4)
Sigma <- Sigma + t(Sigma)
diag(Sigma) <- 1
correct_means_mvrr(Sigma = Sigma, means_i = c(.3, .3, .1, .1),
means_x_a = c(-.1, -.1), x_col = 1:2)
```

---

**correct_r**

*Correct correlations for range restriction and/or measurement error*

Description

Correct correlations for range restriction and/or measurement error

Usage

```r
correct_r(
correction = c("meas", "uvdrr_x", "uvdrr_y", "uvirr_x", "uvirr_y", "bvdrr", "bvrr"),
rxyi,
ux = 1,
uy = 1,
rxx = 1,
ryy = 1,
ux_observed = TRUE,
uy_observed = TRUE,
rxx_restricted = TRUE,
rxx_type = "alpha",
k_items_x = NA,
ryy_restricted = TRUE,
ryy_type = "alpha",
k_items_y = NA,
sign_rxz = 1,
sign_ryz = 1,
n = NULL,
conf_level = 0.95,
correct_bias = FALSE
)
```
Arguments

- **correction**: Type of correction to be applied. Options are "meas", "uvdr_x", "uvdr_y", "uvrr_x", "uvrr_y", "bvdr", "bvrr"
- **rxyi**: Vector of observed correlations.
- **ux**: Vector of u ratios for X.
- **uy**: Vector of u ratios for Y.
- **rxx**: Vector of reliability coefficients for X.
- **ryy**: Vector of reliability coefficients for Y.
- **ux_observed**: Logical vector in which each entry specifies whether the corresponding ux value is an observed-score u ratio (TRUE) or a true-score u ratio. All entries are TRUE by default.
- **uy_observed**: Logical vector in which each entry specifies whether the corresponding uy value is an observed-score u ratio (TRUE) or a true-score u ratio. All entries are TRUE by default.
- **rxx_restricted**: Logical vector in which each entry specifies whether the corresponding rxx value is an incumbent reliability (TRUE) or an applicant reliability. All entries are TRUE by default.
- **rxx_type, ryy_type**: String vector identifying the types of reliability estimates supplied (e.g., "alpha", "retest", "interrater_r", "splithalf"). See the documentation for `ma_r` for a full list of acceptable reliability types.
- **k_items_x, k_items_y**: Numeric vector identifying the number of items in each scale.
- **ryy_restricted**: Logical vector in which each entry specifies whether the corresponding rxx value is an incumbent reliability (TRUE) or an applicant reliability. All entries are TRUE by default.
- **sign_rxz**: Vector of signs of the relationships between X variables and the selection mechanism.
- **sign_ryz**: Vector of signs of the relationships between Y variables and the selection mechanism.
- **n**: Optional vector of sample sizes associated with the rxyi correlations.
- **conf_level**: Confidence level to define the width of the confidence interval (default = .95).
- **correct_bias**: Logical argument that determines whether to correct error-variance estimates for small-sample bias in correlations (TRUE) or not (FALSE). For sporadic corrections (e.g., in mixed artifact-distribution meta-analyses), this should be set to FALSE, the default).

Details

The correction for measurement error is:

\[ \rho_{TP} = \frac{\rho_{XY}}{\sqrt{\rho_{XX} \rho_{YY}}} \]
The correction for univariate direct range restriction is:

$$\rho_{\text{TP}_a} = \left[ \frac{\rho_{XY}}{u_X\sqrt{\rho_{YY}}\sqrt{\left(\frac{1}{u_X^2} - 1\right)\rho_{XY}^2 + 1}} \right] / \sqrt{\rho_{XX}a}$$

The correction for univariate indirect range restriction is:

$$\rho_{\text{TP}_a} = \frac{\rho_{XY}}{u_T\sqrt{\rho_{XX}a\rho_{YY}a}\sqrt{\left(\frac{1}{u_T^2} - 1\right)\frac{\rho_{XY}^2}{\rho_{XX}a\rho_{YY}a} + 1}}$$

The correction for bivariate direct range restriction is:

$$\rho_{\text{TP}_a} = \frac{\frac{\rho_{XY}^2 - 1}{\rho_{XY}}u_Xu_Y + \text{sign} (\rho_{XY})\sqrt{\left(1 - \frac{\rho_{XY}^2}{\rho_{XX}a\rho_{YY}a}\right)\frac{u_X^2u_Y^2}{\rho_{XX}a\rho_{YY}a} + 1}}{\sqrt{\rho_{XX}a\rho_{YY}a}}$$

The correction for bivariate indirect range restriction is:

$$\rho_{\text{TP}_a} = \frac{\rho_{XY}u_Xu_Y + \lambda\sqrt{\left|1 - u_X^2\right|\left|1 - u_Y^2\right|}}{\sqrt{\rho_{XX}a\rho_{YY}a}}$$

where the \(\lambda\) value allows \(u_X\) and \(u_Y\) to fall on either side of unity so as to function as a two-stage correction for mixed patterns of range restriction and range enhancement. The \(\lambda\) value is computed as:

$$\lambda = \text{sign} [\rho_{ST_a}\rho_{SP_a} (1 - u_X)(1 - u_Y)] \frac{\text{sign} (1 - u_X) \min \left(u_X, \frac{1}{u_X}\right) + \text{sign} (1 - u_Y) \min \left(u_Y, \frac{1}{u_Y}\right)}{\min \left(u_X, \frac{1}{u_X}\right) \min \left(u_Y, \frac{1}{u_Y}\right)}$$

Value

Data frame(s) of observed correlations \((r_{XY})\), operational range-restricted correlations corrected for measurement error in Y only \((r_{XP})\), operational range-restricted correlations corrected for measurement error in X only \((r_{TY})\), and range-restricted true-score correlations \((r_{TP})\), range-corrected observed-score correlations \((r_{XYa})\), operational range-corrected correlations corrected for measurement error in Y only \((r_{XPa})\), operational range-corrected correlations corrected for measurement error in X only \((r_{Tya})\), and range-corrected true-score correlations \((r_{TPa})\).

References


Dahlke, J. A., & Wiernik, B. M. (2018). One of these artifacts is not like the others: Accounting for indirect range restriction in organizational and psychological research. Manuscript submitted for review.


**Examples**

```
## Correction for measurement error only
correct_r(correction = "bvirr", rxyi = .3, ux = .8, uy = .8, rxx = .8, ryy = .8,
          ux_observed = TRUE, uy_observed = TRUE, rxx_restricted = TRUE, ryy_restricted = TRUE)

## Correction for direct range restriction in X
correct_r(correction = "uvdrr_x", rxyi = .3, ux = .8, uy = .8, rxx = .8, ryy = .8,
          ux_observed = TRUE, uy_observed = TRUE, rxx_restricted = TRUE, ryy_restricted = TRUE)

correct_r(correction = "uvdrr_x", rxyi = .3, ux = .8, uy = .8, rxx = .8, ryy = .8,
          ux_observed = TRUE, uy_observed = TRUE, rxx_restricted = TRUE, ryy_restricted = TRUE, n = 100)

correct_r(correction = "uvirr_x", rxyi = .3, ux = .8, uy = .8, rxx = .8, ryy = .8,
          ux_observed = TRUE, uy_observed = TRUE, rxx_restricted = TRUE, ryy_restricted = TRUE)

correct_r(correction = "uvirr_x", rxyi = .3, ux = .8, uy = .8, rxx = .8, ryy = .8,
          ux_observed = TRUE, uy_observed = TRUE, rxx_restricted = TRUE, ryy_restricted = TRUE, n = 100)

correct_r(correction = "bvdrr", rxyi = .3, ux = .8, uy = .8, rxx = .8, ryy = .8,
          ux_observed = TRUE, uy_observed = TRUE, rxx_restricted = TRUE, ryy_restricted = TRUE)

correct_r(correction = "bvdrr", rxyi = .3, ux = .8, uy = .8, rxx = .8, ryy = .8,
          ux_observed = TRUE, uy_observed = TRUE, rxx_restricted = TRUE, ryy_restricted = TRUE, n = 100)

## Correction for indirect range restriction in X and Y

```
Usage

correct_r_bias(r, n)

Arguments

r Vector of correlations.

n Vector of sample sizes.

Details

\[ r_c = \frac{r_{obs}}{\left(\frac{2n-2}{2n-1}\right)} \]

Value

Vector of correlations corrected for small-sample bias.

References


Examples

correct_r_bias(r = .3, n = 30)
correct_r_bias(r = .3, n = 300)
correct_r_bias(r = .3, n = 3000)
correct_r_coarseness

width_y = 3,
lbound_x = NULL,
ubound_x = NULL,
lbound_y = NULL,
ubound_y = NULL,
index_values_x = NULL,
index_values_y = NULL
)

Arguments

r Observed correlation.

kx, ky Number of scale points used to measure the x and y variables. Set to NULL to treat as continuously measured.
n Optional sample size.
dist_x, dist_y Assumed latent distribution of the x and y variables.
bin_value_x, bin_value_y Are the scale points used to measure the of the x and y variables assumed to represent bin medians, means, or index values?

width_x, width_y For symmetrically distributed variables, how many standard deviations above/below the latent mean should be be used for the latent variable range to make the correction? (Note: Setting width > 3 produces erratic results.) The latent variable range can alternatively be set using lbound and ubound.

lbound_x, lbound_y What lower bound of the range for the latent x and y variables should be used to make the correction? (Note: For normally distributed variables, setting lbound < -3 produces erratic results.)

ubound_x, ubound_y What upper bound of the range for the latent x and y variables should be used to make the correction? (Note: For normally distributed variables, setting ubound > 3 produces erratic results.)

index_values_x, index_values_y Optional. If bin_value = "index", the bin index values. If unspecified, values 1:k are used.

Value

Vector of correlations corrected for scale coarseness (if n is supplied, corrected error variance and adjusted sample size is also reported).

References


**Examples**

```r
correct_r_coarseness(r = .35, kx = 5, ky = 4, n = 100)
correct_r_coarseness(r = .35, kx = 5, n = 100)
correct_r_coarseness(r = .35, kx = 5, ky = 4, n = 100, dist_x="unif", dist_y="norm")
```

**correct_r_dich**

*Correct correlations for artificial dichotomization of one or both variables*

**Description**

Correct correlations for artificial dichotomization of one or both variables

**Usage**

```r
correct_r_dich(r, px = NA, py = NA, n = NULL, ...)
```

**Arguments**

- `r`: Vector of correlations attenuated by artificial dichomization.
- `px`: Vector of proportions of the distribution on either side of the split applied to X (set as NA if X is continuous).
- `py`: Vector of proportions of the distribution on either side of the split applied to Y (set as NA if Y is continuous).
- `n`: Optional vector of sample sizes.
- `...`: Additional arguments.

**Details**

\[
 r_c = \frac{r_{obs}}{\phi(px) \phi(py) \left[ \frac{1}{px(1-px)} + \frac{1}{py(1-py)} \right]}
\]

**Value**

Vector of correlations corrected for artificial dichomization (if `n` is supplied, corrected error variance and adjusted sample size is also reported).
References

Examples

```r
correct_r_dich(r = 0.32, px = .5, py = .5, n = 100)
```

---

**Correct correlations for uneven/unrepresentative splits**

**Description**
This correction is mathematically equivalent to correcting the correlation for direct range restriction in the split variable.

**Usage**

```r
correct_r_split(r, pi, pa = 0.5, n = NULL)
```

**Arguments**
- `r`: Vector of correlations affected by an uneven or unrepresentative split of a dichotomous variable.
- `pi`: Vector of proportions of incumbent/sample cases in one of the categories of the dichotomous variable.
- `pa`: Vector of proportions of applicant/population cases in one of the categories of the dichotomous variable.
- `n`: Optional vector of sample sizes.

**Details**

\[
rc = \frac{r_{obs}}{u \sqrt{\left(\frac{1}{u^2} - 1\right) r_{obs}^2 + 1}}
\]

where \( u = \sqrt{\frac{p_i(1-p_i)}{p_a(1-p_a)}} \), the ratio of the dichotomous variance in the sample (\( p_i \) is the incumbent/sample proportion in one of the two groups) to the dichotomous variance in the population (\( p_a \) is the applicant/population proportion in one of the two groups). This correction is identical to the correction for univariate direct range restriction, applied to a dichotomous variable.

**Value**
Vector of correlations corrected for unrepresentative splits (if \( n \) is supplied, corrected error variance and adjusted sample size is also reported).
References


Examples

```r
correct_r_split(r = 0.3, pi = .9, pa = .5, n = 100)
```

---

### create_ad

*Generate an artifact distribution object for use in artifact-distribution meta-analysis programs.*

### Description

This function generates artifact-distribution objects containing either interactive or Taylor series artifact distributions. Use this to create objects that can be supplied to the `ma_r_ad` and `ma_r_ad` functions to apply psychometric corrections to barebones meta-analysis objects via artifact distribution methods.

Allows consolidation of observed and estimated artifact information by cross-correcting artifact distributions and forming weighted artifact summaries.

For u ratios, error variances can be computed for independent samples (i.e., settings in which the unrestricted standard deviation comes from an external study) or dependent samples (i.e., settings in which the range-restricted standard deviation comes from a sample that represents a subset of the applicant sample that provided the unrestricted standard deviation). The former circumstance is presumed to be more common, so error variances are computed for independent samples by default.

### Usage

```r
create_ad(
  ad_type = c("tsa", "int"),
  rxxi = NULL,
  n_rxxi = NULL,
  wt_rxxi = n_rxxi,
  rxxi_type = rep("alpha", length(rxxi)),
  k_items_rxxi = rep(NA, length(rxxi)),
  rxxa = NULL,
  n_rxxa = NULL,
  wt_rxxa = n_rxxa,
  rxxa_type = rep("alpha", length(rxxa)),
  k_items_rxxa = rep(NA, length(rxxa)),
  ux = NULL,
  ni_ux = NULL,
  na_ux = NULL,
  wt_ux = ni_ux,
  dep_sds_ux_obs = rep(FALSE, length(ux)),
)```

ut = NULL,
ni_ut = NULL,
na_ut = NULL,
wt_ut = ni_ut,
dep_sds_ut_obs = rep(FALSE, length(ut)),
mean_qxi = NULL,
var_qxi = NULL,
k_qxi = NULL,
mean_n_qxi = NULL,
qxi_dist_type = rep("alpha", length(mean_qxi)),
mean_k_items_qxi = rep(NA, length(mean_qxi)),
mean_rxxi = NULL,
var_rxxi = NULL,
k_rxxi = NULL,
mean_n_rxxi = NULL,
rxxi_dist_type = rep("alpha", length(mean_rxxi)),
mean_k_items_rxxi = rep(NA, length(mean_rxxi)),
mean_qxa = NULL,
var_qxa = NULL,
k_qxa = NULL,
mean_n_qxa = NULL,
qxa_dist_type = rep("alpha", length(mean_qxa)),
mean_k_items_qxa = rep(NA, length(mean_qxa)),
mean_rxxa = NULL,
var_rxxa = NULL,
k_rxxa = NULL,
mean_n_rxxa = NULL,
rxxa_dist_type = rep("alpha", length(mean_rxxa)),
mean_k_items_rxxa = rep(NA, length(mean_rxxa)),
mean_ux = NULL,
var_ux = NULL,
k_ux = NULL,
mean_ni_ux = NULL,
mean_na_ux = rep(NA, length(mean_ux)),
dep_sds_ux_spec = rep(FALSE, length(mean_ux)),
mean_ut = NULL,
var_ut = NULL,
k_ut = NULL,
mean_ni_ut = NULL,
mean_na_ut = rep(NA, length(mean_ut)),
dep_sds_ut_spec = rep(FALSE, length(mean_ut)),
estimate_rxxa = TRUE,
estimate_rxxi = TRUE,
estimate_ux = TRUE,
estimate_ut = TRUE,
var_unbiased = TRUE,
...
Arguments

- **ad_type**: Type of artifact distribution to be computed: Either "tsa" for Taylor series approximation or "int" for interactive.
- **rxxi**: Vector of incumbent reliability estimates.
- **n_rxxi**: Vector of sample sizes associated with the elements of rxxi.
- **wt_rxxi**: Vector of weights associated with the elements of rxxi (by default, sample sizes will be used as weights).
- **rxxi_type, rxxa_type, qxi_dist_type, rxxi_dist_type, qxa_dist_type, rxxa_dist_type**: String vector identifying the types of reliability estimates supplied (e.g., "alpha", "retest", "interrater_r", "splithalf"). See the documentation for ma_r for a full list of acceptable reliability types.
- **k_items_rxxi, mean_k_items_qxi, mean_k_items_rxxi, k_items_rxxa, mean_k_items_qxa, mean_k_items_rxxa**: Numeric vector of the number of items in each scale (or mean number of items, for pre-specified distributions).
- **rxxa**: Vector of applicant reliability estimates.
- **n_rxxa**: Vector of sample sizes associated with the elements of rxxa.
- **wt_rxxa**: Vector of weights associated with the elements of rxxa (by default, sample sizes will be used as weights).
- **ux**: Vector of observed-score u ratios.
- **ni_ux**: Vector of incumbent sample sizes associated with the elements of ux.
- **na_ux**: Vector of applicant sample sizes that can be used in estimating the sampling error of supplied ux values. NULL by default. Only used when ni_ux is not NULL. If supplied, must be either a scalar or the same length as ni_ux.
- **wt_ux**: Vector of weights associated with the elements of ux (by default, sample sizes will be used as weights).
- **dep_sds_ux_obs**: Logical scalar or vector determining whether supplied ux values were computed using dependent samples (TRUE) or independent samples (FALSE).
- **ut**: Vector of true-score u ratios.
- **ni_ut**: Vector of incumbent sample sizes associated with the elements of ut.
- **na_ut**: Vector of applicant sample sizes that can be used in estimating the sampling error of supplied ut values. NULL by default. Only used when ni_ut is not NULL. If supplied, must be either a scalar or the same length as ni_ut.
- **wt_ut**: Vector of weights associated with the elements of ut (by default, sample sizes will be used as weights).
- **dep_sds_ut_obs**: Logical scalar or vector determining whether supplied ut values were computed using dependent samples (TRUE) or independent samples (FALSE).
- **mean_qxi**: Vector that can be used to supply the means of externally computed distributions of incumbent square-root reliabilities.
- **var_qxi**: Vector that can be used to supply the variances of externally computed distributions of incumbent square-root reliabilities.
- **k_qxi**: Vector that can be used to supply the number of studies included in externally computed distributions of incumbent square-root reliabilities.
mean_n_qxi  Vector that can be used to supply the mean sample sizes of externally computed distributions of incumbent square-root reliabilities.

mean_rxxi  Vector that can be used to supply the means of externally computed distributions of incumbent reliabilities.

var_rxxi  Vector that can be used to supply the variances of externally computed distributions of incumbent reliabilities.

k_rxxi  Vector that can be used to supply the number of studies included in externally computed distributions of incumbent reliabilities.

mean_n_rxxi  Vector that can be used to supply the mean sample sizes of externally computed distributions of incumbent reliabilities.

mean_qxa  Vector that can be used to supply the means of externally computed distributions of applicant square-root reliabilities.

var_qxa  Vector that can be used to supply the variances of externally computed distributions of applicant square-root reliabilities.

k_qxa  Vector that can be used to supply the number of studies included in externally computed distributions of applicant square-root reliabilities.

mean_n_qxa  Vector that can be used to supply the mean sample sizes of externally computed distributions of applicant square-root reliabilities.

mean_rxxa  Vector that can be used to supply the means of externally computed distributions of applicant reliabilities.

var_rxxa  Vector that can be used to supply the variances of externally computed distributions of applicant reliabilities.

k_rxxa  Vector that can be used to supply the number of studies included in externally computed distributions of applicant reliabilities.

mean_n_rxxa  Vector that can be used to supply the mean sample sizes of externally computed distributions of applicant reliabilities.

mean_ux  Vector that can be used to supply the means of externally computed distributions of observed-score u ratios.

var_ux  Vector that can be used to supply the variances of externally computed distributions of observed-score u ratios.

k_ux  Vector that can be used to supply the number of studies included in externally computed distributions of observed-score u ratios.

mean_ni_ux  Vector that can be used to supply the mean incumbent sample sizes of externally computed distributions of observed-score u ratios.

mean_na_ux  Vector or scalar that can be used to supply the mean applicant sample size(s) of externally computed distributions of observed-score u ratios.

dep_sds_ux_spec  Logical scalar or vector determining whether externally computed ux distributions were computed using dependent samples (TRUE) or independent samples (FALSE).

mean_ut  Vector that can be used to supply the means of externally computed distributions of true-score u ratios.
var_ut Vector that can be used to supply the variances of externally computed distributions of true-score u ratios.

k_ut Vector that can be used to supply the number of studies included in externally computed distributions of true-score u ratios.

mean_ni_ut Vector that can be used to supply the mean sample sizes for of externally computed distributions of true-score u ratios.

mean_na_ut Vector or scalar that can be used to supply the mean applicant sample size(s) of externally computed distributions of true-score u ratios.

dep_sds_ut_spec Logical scalar or vector determining whether externally computed ut distributions were computed using dependent samples (TRUE) or independent samples (FALSE).

estimate_rxxa Logical argument to estimate rxxa values from other artifacts (TRUE) or to only used supplied rxxa values (FALSE). TRUE by default.

estimate_rxxi Logical argument to estimate rxxi values from other artifacts (TRUE) or to only used supplied rxxi values (FALSE). TRUE by default.

estimate_ux Logical argument to estimate ux values from other artifacts (TRUE) or to only used supplied ux values (FALSE). TRUE by default.

estimate_ut Logical argument to estimate ut values from other artifacts (TRUE) or to only used supplied ut values (FALSE). TRUE by default.

var_unbiased Logical scalar determining whether variance should be unbiased (TRUE) or maximum-likelihood (FALSE).

... Further arguments.

Value

Artifact distribution object (matrix of artifact-distribution means and variances) for use artifact-distribution meta-analyses.

Examples

```r
# Example computed using observed values only:
create_ad(ad_type = "tsa", rxxa = c(.9, .8), n_rxxa = c(50, 150),
          rxxi = c(.8, .7), n_rxxi = c(50, 150),
          ux = c(.9, .8), ni_ux = c(50, 150))

create_ad(ad_type = "int", rxxa = c(.9, .8), n_rxxa = c(50, 150),
          rxxi = c(.8, .7), n_rxxi = c(50, 150),
          ux = c(.9, .8), ni_ux = c(50, 150))

# Example computed using all possible input arguments (arbitrary values):
rxxa <- rxxi <- ux <- ut <- c(.7, .8)
n_rxxa <- n_rxxi <- ni_ux <- ni_ut <- c(50, 100)
na_ux <- na_ut <- c(200, 200)
mean_qxa <- mean_qxi <- mean_ux <- mean_ut <- mean_rxxa <- mean_rxxi <- c(.7, .8)
var_qxa <- var_qxi <- var_ux <- var_ut <- var_rxxa <- var_rxxi <- c(.1, .05)
k_qxa <- k_qxi <- k_ux <- k_ut <- k_rxxa <- k_rxxi <- 2
```
create_ad_group

Generate an artifact distribution object for a dichotomous grouping variable.

Description

This function generates artifact-distribution objects containing either interactive or Taylor series artifact distributions for dichotomous group-membership variables. Use this to create objects that can
be supplied to the `ma_r_ad` and `ma_d_ad` functions to apply psychometric corrections to barebones meta-analysis objects via artifact distribution methods.

Allows consolidation of observed and estimated artifact information by cross-correcting artifact distributions and forming weighted artifact summaries.

**Usage**

```r
create_ad_group(
    ad_type = c("tsa", "int"),
    rGg = NULL,
    n_rGg = NULL,
    wt_rGg = n_rGg,
    pi = NULL,
    pa = NULL,
    n_pi = NULL,
    n_pa = NULL,
    wt_p = n_pi,
    mean_rGg = NULL,
    var_rGg = NULL,
    k_rGg = NULL,
    mean_n_rGg = NULL,
    var_unbiased = TRUE,
    ...
)
```

**Arguments**

- **ad_type** Type of artifact distribution to be computed: Either "tsa" for Taylor series approximation or "int" for interactive.
- **rGg** Vector of incumbent reliability estimates.
- **n_rGg** Vector of sample sizes associated with the elements of `rGg`.
- **wt_rGg** Vector of weights associated with the elements of `rGg` (by default, sample sizes will be used as weights if provided).
- **pi** Vector of incumbent/sample proportions of members in one of the two groups being compared (one or both of `pi/pa` can be vectors - if both are vectors, they must be of equal length).
- **pa** Vector of applicant/population proportions of members in one of the two groups being compared (one or both of `pi/pa` can be vectors - if both are vectors, they must be of equal length).
- **n_pi** Vector of sample sizes associated with the elements in `pi`.
- **n_pa** Vector of sample sizes associated with the elements in `pa`.
- **wt_p** Vector of weights associated with the collective element pairs in `pi` and `pa`.
- **mean_rGg** Vector that can be used to supply the means of externally computed distributions of correlations between observed and latent group membership.
- **var_rGg** Vector that can be used to supply the variances of externally computed distributions of correlations between observed and latent group membership.
k_rGg Vector that can be used to supply the number of studies included in externally computed distributions of correlations between observed and latent group membership.

mean_n_rGg Vector that can be used to supply the mean sample sizes of externally computed distributions of correlations between observed and latent group membership.

var_unbiased Logical scalar determining whether variance should be unbiased (TRUE) or maximum-likelihood (FALSE).

... Further arguments.

Value

Artifact distribution object (matrix of artifact-distribution means and variances) for use in artifact-distribution meta-analyses.

Examples

### Example artifact distribution for a dichotomous grouping variable:
create_ad_group(rGg = c(.8, .9, .95), n_rGg = c(100, 200, 250),
    mean_rGg = .9, var_rGg = .05,
    k_rGg = 5, mean_n_rGg = 100,
    pi = c(.6, .55, .3), pa = .5, n_pi = c(100, 200, 250), n_pa = c(300, 300, 300),
    var_unbiased = TRUE)

create_ad_group(ad_type = "int", rGg = c(.8, .9, .95), n_rGg = c(100, 200, 250),
    mean_rGg = .9, var_rGg = .05,
    k_rGg = 5, mean_n_rGg = 100,
    pi = c(.6, .55, .3), pa = .5, n_pi = c(100, 200, 250), n_pa = c(300, 300, 300),
    var_unbiased = TRUE)

---

create_ad_tibble Create a tibble of artifact distributions by construct

Description

Create a tibble of artifact distributions by construct

Usage

create_ad_tibble(
    ad_type = c("tsa", "int"),
    n = NULL,
    sample_id = NULL,
    construct_x = NULL,
    facet_x = NULL,
    measure_x = NULL,
    construct_y = NULL,
    facet_y = NULL,
    ...
measure_y = NULL,
    rxx = NULL,
    rxx_restricted = TRUE,
    rxx_type = "alpha",
    k_items_x = NA,
    ryy = NULL,
    ryy_restricted = TRUE,
    ryy_type = "alpha",
    k_items_y = NA,
    ux = NULL,
    ux_observed = TRUE,
    uy = NULL,
    uy_observed = TRUE,
    estimate_rxxa = TRUE,
    estimate_rxxi = TRUE,
    estimate_ut = TRUE,
    moderators = NULL,
    cat_moderators = TRUE,
    moderator_type = c("simple", "hierarchical", "none"),
    construct_order = NULL,
    supplemental_ads = NULL,
    data = NULL,
    control = control_psychmeta(),
    ...
)

create_ad_list(
    ad_type = c("tsa", "int"),
    n = NULL,
    sample_id = NULL,
    construct_x = NULL,
    facet_x = NULL,
    measure_x = NULL,
    construct_y = NULL,
    facet_y = NULL,
    measure_y = NULL,
    rxx = NULL,
    rxx_restricted = TRUE,
    rxx_type = "alpha",
    k_items_x = NA,
    ryy = NULL,
    ryy_restricted = TRUE,
    ryy_type = "alpha",
    k_items_y = NA,
    ux = NULL,
    ux_observed = TRUE,
    uy = NULL,
Arguments

**ad_type**  
Type of artifact distributions to be computed: Either "tsa" for Taylor series approximation or "int" for interactive.

**n**  
Vector or column name of sample sizes.

**sample_id**  
Optional vector of identification labels for samples/studies in the meta-analysis.

**construct_x, construct_y**  
Vector of construct names for constructs initially designated as "X" or "Y".

**facet_x, facet_y**  
Vector of facet names for constructs initially designated as "X" or "Y". Facet names "global", "overall", and "total" are reserved to indicate observations that represent effect sizes that have already been composited or that represent construct-level measurements rather than facet-level measurements. To avoid double-compositing, any observation with one of these reserved names will only be eligible for auto-compositing with other such observations and will not be combined with narrow facets.

**measure_x, measure_y**  
Vector of names for measures associated with constructs initially designated as "X" or "Y".

**rxx**  
Vector or column name of reliability estimates for X.

**rxx_restricted**  
Logical vector or column name determining whether each element of rxx is an incumbent reliability (TRUE) or an applicant reliability (FALSE).

**rxx_type, ryy_type**  
String vector identifying the types of reliability estimates supplied. See documentation of **ma_r** for a full list of acceptable values.

**k_items_x, k_items_y**  
Numeric vector identifying the number of items in each scale.

**ryy**  
Vector or column name of reliability estimates for Y.

**ryy_restricted**  
Logical vector or column name determining whether each element of ryy is an incumbent reliability (TRUE) or an applicant reliability (FALSE).

**ux**  
Vector or column name of u ratios for X.
ux_observed Logical vector or column name determining whether each element of ux is an observed-score u ratio (TRUE) or a true-score u ratio (FALSE).

uy Vector or column name of u ratios for Y.

uy_observed Logical vector or column name determining whether each element of uy is an observed-score u ratio (TRUE) or a true-score u ratio (FALSE).

estimate_rxxa Logical argument to estimate rxxa values from other artifacts (TRUE) or to only used supplied rxxa values (FALSE). TRUE by default.

estimate_rxxi Logical argument to estimate rxxi values from other artifacts (TRUE) or to only used supplied rxxi values (FALSE). TRUE by default.

estimate_ux Logical argument to estimate ux values from other artifacts (TRUE) or to only used supplied ux values (FALSE). TRUE by default.

estimate_ut Logical argument to estimate ut values from other artifacts (TRUE) or to only used supplied ut values (FALSE). TRUE by default.

moderators Matrix or column names of moderator variables to be used in the meta-analysis (can be a vector in the case of one moderator).

cat_moderators Logical scalar or vector identifying whether variables in the moderators argument are categorical variables (TRUE) or continuous variables (FALSE).

moderator_type Type of moderator analysis: "none" means that no moderators are to be used, "simple" means that moderators are to be examined one at a time, and "hierarchical" means that all possible combinations and subsets of moderators are to be examined.

construct_order Vector indicating the order in which variables should be arranged, with variables listed earlier in the vector being preferred for designation as X.

supplemental_ads Named list (named according to the constructs included in the meta-analysis) of supplemental artifact distribution information from studies not included in the meta-analysis. This is a list of lists, where the elements of a list associated with a construct are named like the arguments of the create_ad() function.

data Data frame containing columns whose names may be provided as arguments to vector arguments.

control Output from the control_psychmeta() function or a list of arguments controlled by the control_psychmeta() function. Ellipsis arguments will be screened for internal inclusion in control.

... Additional arguments

Value
A tibble of artifact distributions

Examples
## Examples to create Taylor series artifact distributions:
# Overall artifact distributions (not pairwise, not moderated)
create_ad_tibble(ad_type = "tsa", "tsa")
# Overall artifact distributions by moderator combination
create_ad_tibble(ad_type = "tsa",
    n = n, rxx = rxxi, ryy = ryyi,
    construct_x = x_name, construct_y = y_name,
    sample_id = sample_id, moderators = moderator,
    data = data_r_meas_multi,
    control = control_psychmeta(pairwise_ads = FALSE,
                                 moderated_ads = FALSE))

# Pairwise artifact distributions (not moderated)
create_ad_tibble(ad_type = "tsa",
    n = n, rxx = rxxi, ryy = ryyi,
    construct_x = x_name, construct_y = y_name,
    sample_id = sample_id, moderators = moderator,
    data = data_r_meas_multi,
    control = control_psychmeta(pairwise_ads = TRUE,
                                 moderated_ads = FALSE))

# Pairwise artifact distributions by moderator combination
create_ad_tibble(ad_type = "tsa",
    n = n, rxx = rxxi, ryy = ryyi,
    construct_x = x_name, construct_y = y_name,
    sample_id = sample_id, moderators = moderator,
    data = data_r_meas_multi,
    control = control_psychmeta(pairwise_ads = TRUE,
                                 moderated_ads = TRUE))

credible

Function to construct a credibility interval around a mean effect size.

credibility(mean, sd, k = NULL, cred_level = 0.8, cred_method = c("t", "norm"))

mean

Mean effect size.

sd

Residual/true standard deviation of effect sizes, after accounting for variance from artifacts.
k  Number of studies in the meta-analysis.
cred_level  Credibility level that defines the width of the credibility interval (default = .80).
cred_method  Distribution to be used to compute the width of credibility intervals. Available options are "t" for t distribution or "norm" for normal distribution.

Details

\[ CR = \text{mean}_{es} \pm \text{quantile} \times \text{SD}_{es} \]

Value

A matrix of credibility intervals of the specified width.

Examples

credibility(mean = .3, sd = .15, cred_level = .8, cred_method = "norm")
credibility(mean = .3, sd = .15, cred_level = .8, k = 10)
credibility(mean = c(.3, .5), sd = c(.15, .2), cred_level = .8, k = 10)

data_d_bb_multi  Hypothetical d value dataset simulated with sampling error only

Description

Data set for use in example meta-analyses of multiple variables.

Usage

data(data_d_bb_multi)

Format

data.frame

Examples

data(data_d_bb_multi)
### data_d_meas_multi

<table>
<thead>
<tr>
<th>Description</th>
<th>Hypothetical ( d ) value dataset simulated to satisfy the assumptions of the correction for measurement error only in multiple constructs</th>
</tr>
</thead>
</table>

**Usage**

```r
data(data_d_meas_multi)
```

**Format**

`data.frame`

**Examples**

```r
data(data_d_meas_multi)
```

### data_r_bvdr

<table>
<thead>
<tr>
<th>Description</th>
<th>Hypothetical dataset simulated to satisfy the assumptions of the bivariate correction for direct range restriction</th>
</tr>
</thead>
</table>

**Usage**

```r
data(data_r_bvdr)
```

**Format**

`data.frame`

**Examples**

```r
data(data_r_bvdr)
```
**data_r_bvirr**

*Hypothetical dataset simulated to satisfy the assumptions of the bivariate correction for indirect range restriction*

**Description**

Data set for use in example meta-analyses of bivariate indirect range restriction.

**Usage**

```r
data(data_r_bvirr)
```

**Format**

data.frame

**Examples**

```r
data(data_r_bvirr)
```

---

**data_r_gonzalezmule_2014**

*Meta-analysis of OCB correlations with other constructs*

**Description**

Data set to demonstrate corrections for univariate range restriction and measurement error using individual corrections or artifact distributions. NOTE: This is an updated version of the data set reported in the Gonzalez-Mulé, Mount, an Oh (2014) article that was obtained from the first author.

**Usage**

```r
data(data_r_gonzalezmule_2014)
```

**Format**

data.frame

**References**


**Examples**

```r
data(data_r_gonzalezmule_2014)
```
data_r_mcdaniel_1994  Artifact-distribution meta-analysis of the validity of interviews

Description
Data set to demonstrate corrections for univariate range restriction and criterion measurement error using artifact distributions.

Usage
```r
data(data_r_mcdaniel_1994)
```

Format
data.frame

References

Examples
```r
data(data_r_mcdaniel_1994)
```

---

data_r_mcleod_2007  Bare-bones meta-analysis of parenting and childhood depression

Description
Data set to demonstrate bare-bones meta-analysis.

Usage
```r
data(data_r_mcleod_2007)
```

Format
data.frame

References
Examples

data(data_r_meas)

data_r_meas

Hypothetical dataset simulated to satisfy the assumptions of the correction for measurement error only

Description

Data set for use in example meta-analyses correcting for measurement error in two variables.

Usage

data(data_r_meas)

Format

data.frame

Examples

data(data_r_meas)

data_r_meas_multi

Hypothetical correlation dataset simulated to satisfy the assumptions of the correction for measurement error only in multiple constructs

Description

Data set for use in example meta-analyses correcting for measurement error in multiple variables.

Usage

data(data_r_meas_multi)

Format

data.frame

Examples

data(data_r_meas_multi)
data_r_oh_2009

Second order meta-analysis of operational validities of big five personality measures across East Asian countries

**Description**

Example of a second-order meta-analysis of correlations corrected using artifact-distribution methods.

**Usage**

```r
data(data_r_oh_2009)
```

**Format**

data.frame

**References**


**Examples**

```r
data(data_r_oh_2009)
```

data_r_roth_2015

Artifact-distribution meta-analysis of the correlation between school grades and cognitive ability

**Description**

Data set to demonstrate corrections for univariate range restriction and cognitive ability measurement error.

**Usage**

```r
data(data_r_roth_2015)
```

**Format**

data.frame
References


Examples

data(data_r_roth_2015)

---

data_r_uvdrr  *Hypothetical dataset simulated to satisfy the assumptions of the univariate correction for direct range restriction*

Description

Data set for use in example meta-analyses correcting for univariate direct range restriction.

Usage

data(data_r_uvdrr)

Format

data.frame

Examples

data(data_r_uvdrr)

---

data_r_uvirr  *Hypothetical dataset simulated to satisfy the assumptions of the univariate correction for indirect range restriction*

Description

Data set for use in example meta-analyses correcting for univariate indirect range restriction.

Usage

data(data_r_uvirr)

Format

data.frame

Examples

data(data_r_uvirr)
Description

Functions to estimate the values of artifacts from other artifacts. These functions allow for reliability estimates to be corrected/attenuated for range restriction and allow u ratios to be converted between observed-score and true-score metrics. Some functions also allow for the extrapolation of an artifact from other available information.

Available functions include:

- `estimate_rxxa`
  Estimate the applicant reliability of variable X from X’s incumbent reliability value and X’s observed-score or true-score u ratio.

- `estimate_rxxa_u`
  Estimate the applicant reliability of variable X from X’s observed-score and true-score u ratios.

- `estimate_rxxi`
  Estimate the incumbent reliability of variable X from X’s applicant reliability value and X’s observed-score or true-score u ratio.

- `estimate_rxxi_u`
  Estimate the incumbent reliability of variable X from X’s observed-score and true-score u ratios.

- `estimate_ux`
  Estimate the true-score u ratio for variable X from X’s reliability coefficient and X’s observed-score u ratio.

- `estimate uy`
  Estimate the observed-score u ratio for variable X from X’s reliability coefficient and X’s true-score u ratio.

- `estimate_ryya`
  Estimate the applicant reliability of variable Y from Y’s incumbent reliability value, Y’s correlation with X, and X’s u ratio.

- `estimate_ryyi`
  Estimate the incumbent reliability of variable Y from Y’s applicant reliability value, Y’s correlation with X, and X’s u ratio.

- `estimate uy`
  Estimate the observed-score u ratio for variable Y from Y’s applicant and incumbent reliability coefficients.

- `estimate up`
  Estimate the true-score u ratio for variable Y from Y’s applicant and incumbent reliability coefficients.
Usage

estimate_rxxa(
  rxxi,
  ux,
  ux_observed = TRUE,
  indirect_rr = TRUE,
  rxxi_type = "alpha"
)

estimate_rxxi(
  rxxa,
  ux,
  ux_observed = TRUE,
  indirect_rr = TRUE,
  rxxa_type = "alpha"
)

estimate_ut(ux, rxx, rxx_restricted = TRUE)

estimate_ux(ut, rxx, rxx_restricted = TRUE)

estimate_ryya(ryyi, rxyi, ux)

estimate_ryyi(ryya, rxyi, ux)

estimate_uy(ryyi, ryya, indirect_rr = TRUE, ryy_type = "alpha")

estimate_up(ryyi, ryya)

estimate_rxxa_u(ux, ut)

estimate_rxxi_u(ux, ut)

Arguments

rxxi Vector of incumbent reliability estimates for X.
ux Vector of observed-score u ratios for X (if used in the context of estimating a reliability value, a true-score u ratio may be supplied by setting ux_observed to FALSE).
ux_observed Logical vector determining whether each element of ux is an observed-score u ratio (TRUE) or a true-score u ratio (FALSE).
indirect_rr Logical vector determining whether each reliability value is associated with indirect range restriction (TRUE) or direct range restriction (FALSE).
rxxi_type, rxxa_type, ryy_type String vector identifying the types of reliability estimates supplied (e.g., "alpha", "retest", "interrater_r", "splithalf"). See the documentation for ma_r for a full list of acceptable reliability types.
rxxa  Vector of applicant reliability estimates for X.
rxx  Vector of reliability estimates for X (used in the context of estimating ux and ut - specify that reliability is an incumbent value by setting rxx_restricted to FALSE).
rxx_restricted  Logical vector determining whether each element of rxx is an incumbent reliability (TRUE) or an applicant reliability (FALSE).
ut  Vector of true-score u ratios for X.
ryyi  Vector of incumbent reliability estimates for Y.
rxyi  Vector of observed-score incumbent correlations between X and Y.
ryya  Vector of applicant reliability estimates for Y.

Details

#### Formulas to estimate rxxa ####

Formulas for indirect range restriction:

\[
\rho_{XXa} = 1 - u_X^2 (1 - \rho_{XXi})
\]

\[
\rho_{XXa} = \frac{\rho_{XXi}}{\rho_{XXi} + u_T^2 - \rho_{XXa} u_X^2 - u_T^2}
\]

Formula for direct range restriction:

\[
\rho_{XXa} = \frac{\rho_{XXi} u_X^2}{u_T^2 \left[ 1 + \rho_{XXi} \left( \frac{1}{u_X^2} - 1 \right) \right]}
\]

#### Formulas to estimate rxxi ####

Formulas for indirect range restriction:

\[
\rho_{XXi} = 1 - \frac{1 - \rho_{XXa}}{u_X^2}
\]

\[
\rho_{XXi} = 1 - \frac{1 - \rho_{XXa}}{\rho_{XXa} \left[ u_T^2 - (1 - \frac{1}{\rho_{XXa}}) \right]}
\]

Formula for direct range restriction:

\[
\rho_{XXi} = \frac{\rho_{XXa} u_X^2}{1 + \rho_{XXi} (u_X^2 - 1)}
\]

#### Formulas to estimate ut ####

\[
u_T = \sqrt{\frac{\rho_{XXi} u_X^2}{1 + \rho_{XXi} u_X^2 - u_X^2}}
\]

\[
u_T = \sqrt{\frac{u_X^2 - (1 - \rho_{XXa})}{\rho_{XXa}}}
\]
#### Formulas to estimate $u_X$ ####

\[ u_X = \sqrt{\frac{u_T^2}{\rho_{XX_i} \left( 1 + \frac{u_T^2}{\rho_{XX_i}} - u_T^2 \right)}} \]

\[ u_X = \sqrt{\rho_{XX_a} \left[ u_T^2 - \left( 1 - \frac{1}{\rho_{XX_a}} \right) \right]} \]

#### Formula to estimate $\rho_{YY_a}$ ####

\[ \rho_{YY_a} = 1 - \frac{1 - \rho_{YY_i}}{1 - \rho_{XY} \left( 1 - \frac{1}{u_X^2} \right)} \]

#### Formula to estimate $\rho_{YY_i}$ ####

\[ \rho_{YY_i} = 1 - (1 - \rho_{YY_a}) \left[ 1 - \rho_{XY} \left( 1 - \frac{1}{u_X^2} \right) \right] \]

#### Formula to estimate $u_Y$ ####

\[ u_Y = \sqrt{\frac{1 - \rho_{YY_a}}{1 - \rho_{YY_i}}} \]

#### Formula to estimate $u_P$ ####

\[ u_P = \sqrt{\frac{1 - \rho_{YY_a} - (1 - \rho_{YY_a})}{\rho_{YY_a}}} \]

**Value**

A vector of estimated artifact values.

**References**


estimate_length_sb

Inverse Spearman-Brown formula to estimate the amount by which a measure would have to be lengthened or shortened to achieve a desired level of reliability

Examples

estimate_rxxa(rxxi = .8, ux = .8, ux_observed = TRUE)
estimate_rxxi(rxxa = .8, ux = .8, ux_observed = TRUE)
estimate_ut(ux = .8, rxx = .8, rxx_restricted = TRUE)
estimate_ux(ut = .8, rxx = .8, rxx_restricted = TRUE)
estimate_ryya(ryyi = .8, rxyi = .3, ux = .8)
estimate_ryyi(ryya = .8, rxyi = .3, ux = .8)
estimate_uy(ryyi = c(.5, .7), ryya = c(.7, .8))
estimate_up(ryyi = c(.5, .7), ryya = c(.7, .8))
estimate_rxxa_u(ux = c(.7, .8), ut = c(.65, .75))
estimate_rxxi_u(ux = c(.7, .8), ut = c(.65, .75))

Description

This function implements the inverse of the Spearman-Brown prophecy formula and answers the question: "How much would I have to increase (do decrease) the length of this measure to obtain a desired reliability level given the current reliability of the measure?" The result of the function is the multiplier by which the length of the original measure should be adjusted. The formula implemented here assumes that all items added to (or subtracted from) the measure will be parallel forms of the original items.

Usage

estimate_length_sb(rel_initial, rel_desired)

Arguments

rel_initial Initial reliability of a measure.
rel_desired Desired reliability of a lengthened or shortened measure.

Details

This is computed as:

\[ k^* = \frac{\rho_X^* \left( \rho_{XX} - 1 \right)}{\left( \rho_{XX} - 1 \right) \rho_{XX}} \]

where \( \rho_{XX} \) is the initial reliability, \( \rho_X^* \) is the predicted reliability of a measure with a different length, and \( k^* \) is the number of times the measure would have to be lengthened to obtain a reliability equal to \( \rho_X^* \).
The estimated number of times by which the number of items in the initial measure would have to be multiplied to achieve the desired reliability.

**References**


**Examples**

```r
## Estimated k to achieve a reliability of .8 from a measure with an initial reliability of .7
estimate_length_sb(rel_initial = .7, rel_desired = .8)

## Estimated k to achieve a reliability of .8 from a measure with an initial reliability of .9
estimate_length_sb(rel_initial = .9, rel_desired = .8)
```

**Description**

This family of functions computes univariate descriptive statistics for the products of two variables denoted as "x" and "y" (e.g., mean(x * y) or var(x * y)) and the covariance between the products of "x" and "y" and of "u" and "v" (e.g., cov(x * y, u * v) or cor(x * y, u * v)). These functions presume all variables are random normal variables.

Available functions include:

- `estimate_mean_prod`
  - Estimate the mean of the product of two variables: x * y.
- `estimate_var_prod`
  - Estimate the variance of the product of two variables: x * y.
- `estimate_cov_prods`
  - Estimate the covariance between the products of two pairs of variables: x * y and u * v.
- `estimate_cor_prods`
  - Estimate the correlation between the products of two pairs of variables: x * y and u * v.

**Usage**

```r
estimate_mean_prod(mu_x, mu_y, cov_xy)

estimate_var_prod(mu_x, mu_y, var_x, var_y, cov_xy)

estimate_cov_prods(mu_x, mu_y, mu_u, mu_v, cov_xu, cov_xv, cov_yu, cov_yv)
```
estimate_cor_prods(
    mu_x,
    mu_y,
    mu_u,
    mu_v,
    var_x,
    var_y,
    var_u,
    var_v,
    cov_xu,
    cov_xv,
    cov_yu,
    cov_yv,
    cov_xy,
    cov_uv
)

Arguments

- **mu_x**: Expected value of variable x.
- **mu_y**: Expected value of variable y.
- **cov_xy**: Covariance between x and y.
- **var_x**: Variance of variable x.
- **var_y**: Variance of variable y.
- **mu_u**: Expected value of variable u.
- **mu_v**: Expected value of variable v.
- **cov_xu**: Covariance between x and u.
- **cov_xv**: Covariance between x and v.
- **cov_yu**: Covariance between y and u.
- **cov_yv**: Covariance between y and v.
- **var_u**: Variance of variable u.
- **var_v**: Variance of variable v.
- **cov_uv**: Covariance between u and v.

Value

An estimated statistic computed from the products of random, normal variables.

References


\section*{estimate_q_dist}

\textbf{Estimate descriptive statistics of square-root reliabilities}

\textbf{Description}

Estimate descriptive statistics of square-root reliabilities from descriptive statistics of reliabilities via Taylor series approximation.

\textbf{Usage}

\begin{verbatim}
  estimate_q_dist(mean_rel, var_rel)
\end{verbatim}

\textbf{Arguments}

\begin{verbatim}
mean_rel  Mean reliability value.
var_rel   Variance of reliability values.
\end{verbatim}

\textbf{Details}

\[ \text{var}_{qX} = \frac{\text{var}_{\rho XX}}{4q_X^2} \]

\textbf{Value}

The estimated mean and variance of a distribution of square-root reliability values.

\textbf{Examples}

\begin{verbatim}
  estimate_q_dist(mean_rel = .8, var_rel = .15)
\end{verbatim}

\section*{estimate_rel_dist}

\textbf{Estimate descriptive statistics of reliabilities}

\textbf{Description}

Estimate descriptive statistics of reliabilities from descriptive statistics of square-root reliabilities via Taylor series approximation.

\textbf{Usage}

\begin{verbatim}
  estimate_rel_dist(mean_q, var_q)
\end{verbatim}

\textbf{Arguments}

\begin{verbatim}
mean_q    Mean square-root reliability value.
var_q     Variance of square-root reliability values.
\end{verbatim}
estimate_rel_sb

Details

\[ \text{var}_{\rho_{XX}} = 4q_{X}\text{var}_{\rho_{XX}} \]

Value

The estimated mean and variance of a distribution of reliability values.

Examples

```
estimate_rel_dist(mean_q = .9, var_q = .05)
```

---

**estimate_rel_sb**  
*Spearman-Brown prophecy formula to estimate the reliability of a*  
*lengthened measure*

Description

This function implements the Spearman-Brown prophecy formula for estimating the reliability of a lengthened (or shortened) measure. The formula implemented here assumes that all items added to (or subtracted from) the measure will be parallel forms of the original items.

Usage

```
estimate_rel_sb(rel_initial, k)
```

Arguments

- rel_initial: Initial reliability of a measure.
- k: The number of times by which the measure should be lengthened (if k > 1) or shortened (if k < 1), assuming that all new items are parallel forms of initial items.

Details

This is computed as:

\[ \rho^*_XX = \frac{k\rho_{XX}}{1 + (k - 1)\rho_{XX}} \]

where \( \rho_{XX} \) is the initial reliability, \( k \) is the multiplier by which the measure is to be lengthened (or shortened), and \( \rho^*_XX \) is the predicted reliability of a measure with a different length.

Value

The estimated reliability of the lengthened (or shortened) measure.
References


Examples

```r
## Double the length of a measure with an initial reliability of .7
estimate_rel_sb(rel_initial = .7, k = 2)

## Halve the length of a measure with an initial reliability of .9
estimate_rel_sb(rel_initial = .9, k = .5)
```

---

**estimate_u**

*Estimate u ratios from available artifact information*

**Description**

Uses information about standard deviations, reliability estimates, and selection ratios to estimate u ratios. Selection ratios are only used to estimate u when no other information is available, but estimates of u computed from SDs and reliabilities will be averaged to reduce error.

**Usage**

```r
estimate_u(
  measure_id = NULL,
  sdi = NULL,
  sda = NULL,
  rxxi = NULL,
  rxxa = NULL,
  item_ki = NULL,
  item_ka = NULL,
  n = NULL,
  meani = NULL,
  sr = NULL,
  rxya_est = NULL,
  data = NULL
)
```

**Arguments**

- `measure_id` Vector of measure identifiers.
- `sdi` Scalar or vector containing restricted standard deviation(s).
- `sda` Scalar or vector containing unrestricted standard deviation(s).
- `rxxi` Scalar or vector containing restricted reliability coefficient(s).
- `rxxa` Scalar or vector containing unrestricted reliability coefficient(s).
item_ki Scalar or vector containing the number of items used in measures within samples.

item_ka Scalar or vector indicating the number of items toward which reliability estimates should be adjusted using the Spearman-Brown formula.

n Vector of sample sizes.

meani Vector of sample means.

sr Vector of selection ratios (used only when no other useable u-ratio inputs are available).

rxya_est Vector of estimated unrestricted correlations between the selection mechanism and the variable of interest (used only when sr is used).

data Optional data frame containing any or all information for use in other arguments.

Value

A vector of estimated u ratios.

Examples

```r
sdi <- c(1.4, 1.2, 1.3, 1.4)
sda <- 2
rxxi <- c(.6, .7, .75, .8)
rxxa <- c(.9, .95, .8, .9)
item_ki <- c(12, 12, 12, NA)
item_ka <- NULL
n <- c(200, 200, 200, 200)
meani <- c(2, 1, 2, 3)
sr <- c(.5, .6, .7, .4)
rxya_est <- .5

## Estimate u from standard deviations only:
estimate_u(sdi = sdi, sda = sda)

## Estimate u from incumbent standard deviations and the
## mixture standard deviation:
estimate_u(sdi = sdi, sda = "mixture", meani = meani, n = n)

## Estimate u from reliability information:
estimate_u(rxxi = rxxi, rxxa = rxxa)

## Estimate u from both standard deviations and reliabilities:
estimate_u(sdi = sdi, sda = sda, rxxi = rxxi, rxxa = rxxa, item_ki = item_ki, item_ka = item_ka, n = n,
meani = meani, sr = sr, rxya_est = rxya_est)

estimate_u(sdi = sdi, sda = "average", rxxi = rxxi, rxxa = "average", item_ki = item_ki, item_ka = item_ka, n = n, meani = meani)

## Estimate u from selection ratios as direct range restriction:
estimate_u(sr = sr)
```
## Estimate u from selection ratios as indirect range restriction:

```
estimate_u(sr = sr, rxya_est = rxya_est)
```

---

**estimate_var_artifacts**

*Taylor series approximations for the variances of estimates artifact distributions.*

---

**Description**

Taylor series approximations to estimate the variances of artifacts that have been estimated from other artifacts. These functions are implemented internally in the `create_ad` function and related functions, but are useful as general tools for manipulating artifact distributions.

Available functions include:

- `estimate_var_qxi`
  Estimate the variance of a qxi distribution from a qxa distribution and a distribution of u ratios.

- `estimate_var_rxxi`
  Estimate the variance of an rxxi distribution from an rxxa distribution and a distribution of u ratios.

- `estimate_var_qxa`
  Estimate the variance of a qxa distribution from a qxi distribution and a distribution of u ratios.

- `estimate_var_rxxa`
  Estimate the variance of an rxxa distribution from an rxxi distribution and a distribution of u ratios.

- `estimate_var_ut`
  Estimate the variance of a true-score u ratio distribution from an observed-score u ratio distribution and a reliability distribution.

- `estimate_var_ux`
  Estimate the variance of an observed-score u ratio distribution from a true-score u ratio distribution and a reliability distribution.

- `estimate_var_qyi`
  Estimate the variance of a qyi distribution from the following distributions: qya, rxyi, and ux.

- `estimate_var_ryyi`
  Estimate the variance of an ryyi distribution from the following distributions: ryya, rxyi, and ux.

- `estimate_var_qya`
  Estimate the variance of a qya distribution from the following distributions: qyi, rxyi, and ux.

- `estimate_var_ryya`
  Estimate the variance of an ryya distribution from the following distributions: ryyi, rxyi, and ux.
Usage

estimate_var_qxi(
    qxa,
    var_qxa = 0,
    ux,
    var_ux = 0,
    cor_qxa_ux = 0,
    ux_observed = TRUE,
    indirect_rr = TRUE,
    qxa_type = "alpha"
)

estimate_var_qxa(
    qxi,
    var_qxi = 0,
    ux,
    var_ux = 0,
    cor_qxi_ux = 0,
    ux_observed = TRUE,
    indirect_rr = TRUE,
    qxi_type = "alpha"
)

estimate_var_rxxi(
    rxxa,
    var_rxxa = 0,
    ux,
    var_ux = 0,
    cor_rxxa_ux = 0,
    ux_observed = TRUE,
    indirect_rr = TRUE,
    rxxa_type = "alpha"
)

estimate_var_rxxa(
    rxxi,
    var_rxxi = 0,
    ux,
    var_ux = 0,
    cor_rxxi_ux = 0,
    ux_observed = TRUE,
    indirect_rr = TRUE,
    rxxi_type = "alpha"
)

estimate_var_ut(
    rxx,
    var_rxx = 0,
ux,
var_ux = 0,
cor_rxx_ux = 0,
rxx_restricted = TRUE,
rxx_as_qx = FALSE
)

estimate_var_ux(
  rxx,
  var_rxx = 0,
  ut,
  var_ut = 0,
  cor_rxx_ut = 0,
  rxx_restricted = TRUE,
  rxx_as_qx = FALSE
)

estimate_var_ryya(
  ryyi,
  var_ryyi = 0,
  rxyi,
  var_rxyi = 0,
  ux,
  var_ux = 0,
  cor_ryyi_rxyi = 0,
  cor_ryyi_ux = 0,
  cor_rxyi_ux = 0
)

estimate_var_qya(
  qyi,
  var_qyi = 0,
  rxyi,
  var_rxyi = 0,
  ux,
  var_ux = 0,
  cor_qyi_rxyi = 0,
  cor_qyi_ux = 0,
  cor_rxyi_ux = 0
)

estimate_var_qyi(
  qya,
  var_qya = 0,
  rxyi,
  var_rxyi = 0,
  ux,
  var_ux = 0,
cor_qya_rxyi = 0,
cor_qya_ux = 0,
cor_rxyi_ux = 0
)
estimate_var_ryyi(
  ryya,
  var_ryya = 0,
  rxyi,
  var_rxyi = 0,
  ux,
  var_ux = 0,
  cor_ryya_rxyi = 0,
  cor_ryya_ux = 0,
  cor_rxyi_ux = 0
)

Arguments
qxa
  Square-root of applicant reliability estimate.
var_qxa
  Variance of square-root of applicant reliability estimate.
ux
  Observed-score u ratio.
var_ux
  Variance of observed-score u ratio.
cor_qxa_ux
  Correlation between qxa and ux.
ux_observed
  Logical vector determining whether u ratios are observed-score u ratios (TRUE) or true-score u ratios (FALSE).
indirect_rr
  Logical vector determining whether reliability values are associated with indirect range restriction (TRUE) or direct range restriction (FALSE).
qxi
  Square-root of incumbent reliability estimate.
var_qxi
  Variance of square-root of incumbent reliability estimate.
cor_qxi_ux
  Correlation between qxi and ux.
rxxa
  Incumbent reliability value.
var_rxxa
  Variance of incumbent reliability values.
cor_rxxa_ux
  Correlation between rxxa and ux.
rxxi
  Incumbent reliability value.
var_rxxi
  Variance of incumbent reliability values.
cor_rxxi_ux
  Correlation between rxxi and ux.
rxxi_type, rxxa_type, qxi_type, qxa_type
  String vector identifying the types of reliability estimates supplied (e.g., "alpha", "retest", "interrater_r", "splithalf"). See the documentation for \texttt{ma_r} for a full list of acceptable reliability types.
rxx
  Generic argument for a reliability estimate (whether this is a reliability or the square root of a reliability is clarified by the \texttt{rxx_as_qx} argument).
var_rxx  Generic argument for the variance of reliability estimates (whether this pertains to reliabilities or the square roots of reliabilities is clarified by the rxx_as_qx argument).

cor_rxx_ux  Correlation between rxx and ux.

rxx_restricted  Logical vector determining whether reliability estimates were incumbent reliabilities (TRUE) or applicant reliabilities (FALSE).

rxx_as_qx  Logical vector determining whether the reliability estimates were reliabilities (TRUE) or square-roots of reliabilities (FALSE).

ut  True-score u ratio.

var_ut  Variance of true-score u ratio.

cor_rxx_ut  Correlation between rxx and ut.

ryyi  Incumbent reliability value.

var_ryyi  Variance of incumbent reliability values.

rxyi  Incumbent correlation between X and Y.

var_rxyi  Variance of incumbent correlations.

cor_ryyi_rxyi  Correlation between ryyi and rxyi.

cor_ryyi_ux  Correlation between ryyi and ux.

cor_rxyi_ux  Correlation between rxyi and ux.

qyi  Square-root of incumbent reliability estimate.

var_qyi  Variance of square-root of incumbent reliability estimate.

qxyi  Correlation between qyi and rxyi.

qya  Square-root of applicant reliability estimate.

var_qya  Variance of square-root of applicant reliability estimate.

cor_qya_rxyi  Correlation between qya and rxyi.

cor_qya_ux  Correlation between qya and ux.

ryya  Applicant reliability value.

var_ryya  Variance of applicant reliability values.

cor_ryya_rxyi  Correlation between ryya and rxyi.

cor_ryya_ux  Correlation between ryya and ux.

Details

#### Partial derivatives to estimate the variance of qxa using ux ####

Indirect range restriction:

\[
\begin{align*}
    b_{u_X} &= \frac{(q_{X_i}^2 - 1)u_X}{\sqrt{(q_{X_i}^2 - 1)u_X^2 + 1}} \\
    b_{q_{X_i}} &= \frac{q_{X_i}^2u_X^2}{\sqrt{(q_{X_i}^2 - 1)u_X^2 + 1}}
\end{align*}
\]
Direct range restriction:

\[ b_{u_X} = \frac{q_X^2(u_X^2 - 1)u_X}{\sqrt{-\frac{q_X^2}{q_X(a - 1) - u_X^2}}(q_X^2(u_X^2 - 1) - u_X^2)^2} \]

\[ b_{q_X} = \frac{q_Xu_X^2}{\sqrt{-\frac{q_X^2}{q_X(a - 1) - u_X^2}}(q_X^2(u_X^2 - 1) - u_X^2)^2} \]

#### Partial derivatives to estimate the variance of \( r_{XXa} \) using \( u_X \)

Indirect range restriction:

\[ b_{u_X} = 2(\rho_{XX}, - 1)u_X \]

\[ \rho_{XX} : b_{\rho_{XX}} = u_X^2 \]

Direct range restriction:

\[ b_{u_X} = \frac{2(\rho_{XX}, - 1)\rho_{XX}u_X}{(-\rho_{XX}u_X^3 + \rho_{XX} + u_X^2)^2} \]

\[ b_{\rho_{XX}} = \frac{u_X^2}{(-\rho_{XX}u_X^3 + \rho_{XX} + u_X^2)^2} \]

#### Partial derivatives to estimate the variance of \( r_{XXa} \) using \( u_T \)

\[ b_{u_T} = \frac{2(\rho_{XX}, - 1)\rho_{XX}u_T}{(-\rho_{XX}u_T^3 + \rho_{XX} + u_T^2)^2} \]

\[ b_{\rho_{XX}} = \frac{u_T^2}{(-\rho_{XX}u_T^3 + \rho_{XX} + u_T^2)^2} \]

#### Partial derivatives to estimate the variance of \( q_{xa} \) using \( u_T \)

\[ b_{u_T} = \frac{q_X^2(u_X^2 - 1)u_T}{\sqrt{-\frac{q_X^2}{q_X(a - 1) - u_T^2}}(q_X^2(u_T^2 - 1) - u_T^2)^2} \]

\[ b_{q_X} = \frac{q_Xu_T^2}{\sqrt{-\frac{q_X^2}{q_X(a - 1) - u_T^2}}(q_X^2(u_T^2 - 1) - u_T^2)^2} \]

#### Partial derivatives to estimate the variance of \( q_{xi} \) using \( u_X \)

Indirect range restriction:

\[ b_{u_X} = \frac{1 - q_{xa}^2}{u_X^3\sqrt{q_X^2 + u_X^2 - 1}} \]

\[ b_{q_{xa}} = \frac{q_X}{u_X^2\sqrt{q_X(a - 1) + 1}} \]
Direct range restriction:

\[ b_{u_X} = -\frac{q_{X_a}^2 (q_{X_a}^2 - 1) u_X}{\sqrt{\frac{q_{X_a}^2 u_X^2}{q_{X_a}^2 (u_X - 1) + 1} (q_{X_a}^2 (u_X^2 - 1) + 1)^2}} \]

\[ b_{q_{X_a}} = \frac{q_{X_a} u_X^2}{\sqrt{\frac{q_{X_a}^2 u_X^2}{q_{X_a}^2 (u_X - 1) + 1} (q_{X_a}^2 (u_X^2 - 1) + 1)^2}} \]

#### Partial derivatives to estimate the variance of \( r_{X_i} \) using \( u_X \)

Indirect range restriction:

\[ b_{u_X} = \frac{2 - 2 \rho_{XX} u_X^3}{u_X^3} \]

\[ b_{\rho_{XX}} = \frac{1}{u_X^2} \]

Direct range restriction:

\[ b_{u_X} = -\frac{2 (\rho_{XX} - 1) \rho_{XX} u_X}{(\rho_{XX} (u_X^2 - 1) + 1)^2} \]

\[ b_{\rho_{XX}} = \frac{u_{u_T}^2}{(\rho_{XX} (u_T^2 - 1) + 1)^2} \]

#### Partial derivatives to estimate the variance of \( r_{X_i} \) using \( u_T \)

\[ u_{u_T} : b_{u_T} = -\frac{2 (\rho_{XX} - 1) \rho_{XX} u_T}{(\rho_{XX} (u_T^2 - 1) + 1)^2} \]

\[ b_{\rho_{XX}} = \frac{u_{u_T}^2}{(\rho_{XX} (u_T^2 - 1) + 1)^2} \]

#### Partial derivatives to estimate the variance of \( q_{X_i} \) using \( u_T \)

\[ b_{u_T} = -\frac{(q_{X_a}^2 - 1) q_{X_a}^2 (q_{X_a}^2 + 1) u_T}{\sqrt{\frac{q_{X_a}^2 u_T^2}{q_{X_a}^2 (u_T^2 - q_{X_a}^2)^2 + 1} (q_{X_a}^2 u_T^2 - q_{X_a}^2 + 1)^2}} \]

\[ b_{q_{X_a}} = \frac{q_{X_a} u_T^2}{\sqrt{\frac{q_{X_a}^2 u_T^2}{q_{X_a}^2 (u_T^2 - q_{X_a}^2)^2 + 1} (q_{X_a}^2 u_T^2 - q_{X_a}^2 + 1)^2}} \]

#### Partial derivatives to estimate the variance of \( u_T \) using \( q_{X_i} \)

\[ b_{u_X} = \frac{q_{X_a}^2 u_X}{\sqrt{\frac{q_{X_a}^2 u_X^2}{(q_{X_i}^2 - 1) u_X^2 + 1} (q_{X_i}^2 - 1) u_X^2 + 1)^2}} \]
\[ b_{it} = -\frac{u^2_t (u^2_t - 1)}{\sqrt{u^2_t} \sqrt{(q^2_t, u^2_t - 1)}} \]

#### Partial derivatives to estimate the variance of ut using rxxi ####

\[ b_{uX} = \frac{\rho_{XX, uX}}{\sqrt{\rho_{XX, uX}^2 - 1}(\rho_{XX, uX}^2 - 1)} \]
\[ b_{\rho_{XX, uX}} = -\frac{u^2_t (u^2_t - 1)}{2\sqrt{\rho_{XX, uX}^2 - 1}(\rho_{XX, uX}^2 - 1)} \]

#### Partial derivatives to estimate the variance of ut using qxa ####

\[ b_{uX} = \frac{u^2_t}{\sqrt{q^2_{Xa} + u^2_t - 1}} \]
\[ b_{q_{Xa}} = \frac{1 - u^2_t}{\sqrt{q^2_{Xa} + u^2_t - 1}} \]

#### Partial derivatives to estimate the variance of ut using rxxa ####

\[ b_{uX} = \frac{u^2_t}{\rho_{XX, uX}} \]
\[ b_{\rho_{XX, uX}} = \frac{1 - u^2_t}{2\rho_{XX, uX}^2} \]

#### Partial derivatives to estimate the variance of ux using qxi ####

\[ b_{uT} = \frac{\sqrt{u^2_T}(u^2_T - 1)}{u^2_T - q^2_{X_t} \left( u^2_T - 1 \right)^2} \]
\[ b_{q_{X_t}} = \frac{q^2_{X_t}(u^2_T - 1) \left( u^2_T \right)^{1.5}}{u^2_T} \]

#### Partial derivatives to estimate the variance of ux using rxxi ####

\[ b_{uT} = \frac{\rho_{XX, uT}}{\sqrt{-\rho_{XX, uT}^2 + \rho_{XX, uT}^2}} \]
\[ b_{\rho_{XX, uT}} = \frac{u^2_T}{-\rho_{XX, uT}^2 + \rho_{XX, uT}^2} \]
\[b_{\rho_{XX_i}} = \frac{(u_T^2 - 1) \left( -\rho_{XX_i} u_T^2 + u_T \right)}{2u_T^2} \]

#### Partial derivatives to estimate the variance of \( u_x \) using \( qxa \) ####

\[b_{u_T} = \frac{q_X^2 u_T}{\sqrt{q_X^2 (u_T^2 - 1) + 1}}\]

\[b_{q_{XX_{a}}} = \frac{q_X (u_T - 1)}{\sqrt{q_X^2 (u_T^2 - 1) + 1}}\]

#### Partial derivatives to estimate the variance of \( u_x \) using \( rXX_{a} \) ####

\[b_{u_T} = \frac{\rho_{XX_{a}} u_T}{\sqrt{\rho_{XX_{a}} (u_T^2 - 1) + 1}}\]

\[b_{\rho_{XX_{a}}} = \frac{u_T^2 - 1}{2\sqrt{\rho_{XX_{a}} (u_T^2 - 1) + 1}}\]

#### Partial derivatives to estimate the variance of \( r_{YY_i} \) ####

\[b_{\rho_{YY_i}} = \frac{1}{\rho_{XY_i}^2 \left( \frac{1}{u_X^2} - 1 \right) + 1}\]

\[b_{u_X} = \frac{2(\rho_{YY_i} - 1)\rho_{XX_{i}} u_X}{(u_X^2 - \rho_{XX_{i}}^2 (u_X^2 - 1))^2}\]

\[b_{\rho_{XY_i}} = \frac{2(\rho_{YY_i} - 1)\rho_{XX_{i}} u_X^2 (u_X^2 - 1)}{(u_X^2 - \rho_{XX_{i}}^2 (u_X^2 - 1))^2}\]

#### Partial derivatives to estimate the variance of \( qya \) ####

\[b_{q_Y_i} = \frac{q_Y_i}{\left[ 1 - \rho_{XX_{i}}^2 \left( \frac{1}{u_X^2} - 1 \right) \right] \sqrt{1 - \frac{1 - q_Y_i^2}{1 - \rho_{XX_{i}}^2 \left( \frac{1}{u_X^2} - 1 \right) \left( \frac{1}{u_X^2} - 1 \right)}}}\]

\[b_{u_X} = - \frac{(1 - q_Y_i^2) \rho_{XY_i}^2}{u_X^2 \left[ 1 - \rho_{XX_{i}}^2 \left( \frac{1}{u_X^2} - 1 \right) \right] \sqrt{1 - \frac{1 - q_Y_i^2}{1 - \rho_{XX_{i}}^2 \left( \frac{1}{u_X^2} - 1 \right) \left( \frac{1}{u_X^2} - 1 \right)}}}\]

\[b_{\rho_{XY_i}} = - \frac{(1 - q_Y_i^2) \rho_{XY_i} (1 - \frac{1}{u_X^2})}{\left[ 1 - \rho_{XX_{i}}^2 \left( \frac{1}{u_X^2} - 1 \right) \right] \sqrt{1 - \frac{1 - q_Y_i^2}{1 - \rho_{XX_{i}}^2 \left( \frac{1}{u_X^2} - 1 \right) \left( \frac{1}{u_X^2} - 1 \right)}}}\]

#### Partial derivatives to estimate the variance of \( r_{YY_i} \) ####
$$\rho_{YY_a} : b_{\rho_{YY_a}} = \rho_{XY_i}^2 \left( \frac{1}{u_X^2} - 1 \right) + 1$$

$$b_{u_X} = -\frac{2(\rho_{YY_a} - 1)\rho_{XY_i}^2}{u_X^3}$$

$$b_{\rho_{XY_i}} = -\frac{2(\rho_{YY_a} - 1)\rho_{XY_i}(u_X^2 - 1)}{u_X^3}$$

#### Partial derivatives to estimate the variance of qyi ####

$$b_{q_{Ya}} = \frac{q_{Y_a} \left[ 1 - \rho_{XY_i}^2 \left( 1 - \frac{1}{u_X^2} \right) \right]}{\sqrt{1 - (1 - q_{Y_a}) \left[ 1 - \rho_{XY_i}^2 \left( 1 - \frac{1}{u_X} \right) \right]}}$$

$$b_{u_X} = \frac{(1 - q_{Y_a}^2)\rho_{XY_i} \left( 1 - \frac{1}{u_X^2} \right)}{\sqrt{1 - (1 - q_{Y_a}) \left[ 1 - \rho_{XY_i}^2 \left( 1 - \frac{1}{u_X} \right) \right]}}$$

$$b_{\rho_{XY_i}} = \frac{(1 - q_{Y_a}^2)\rho_{XY_i}^2}{u_X^3 \sqrt{1 - (1 - q_{Y_a}) \left[ 1 - \rho_{XY_i}^2 \left( 1 - \frac{1}{u_X} \right) \right]}}$$

**Examples**

```r
estimate_var_qxi(qxa = c(.8, .85, .9, .95), var_qxa = c(.02, .03, .04, .05),
ux = .8, var_ux = 0,
ux_observed = c(TRUE, TRUE, FALSE, FALSE),
indirect_rr = c(TRUE, FALSE, TRUE, FALSE))

estimate_var_qxa(qxi = c(.8, .85, .9, .95), var_qxi = c(.02, .03, .04, .05),
ux = .8, var_ux = 0,
ux_observed = c(TRUE, TRUE, FALSE, FALSE),
indirect_rr = c(TRUE, FALSE, TRUE, FALSE))

estimate_var_rxxa(rxxa = c(.8, .85, .9, .95),
var_rxxa = c(.02, .03, .04, .05), ux = .8, var_ux = 0,
ux_observed = c(TRUE, TRUE, FALSE, FALSE),
indirect_rr = c(TRUE, FALSE, TRUE, FALSE))

estimate_var_rxxa(rxxi = c(.8, .85, .9, .95), var_rxxi = c(.02, .03, .04, .05),
ux = .8, var_ux = 0,
ux_observed = c(TRUE, TRUE, FALSE, FALSE),
indirect_rr = c(TRUE, FALSE, TRUE, FALSE))

estimate_var_ut(rxx = c(.8, .85, .9, .95), var_rxx = 0,
ux = c(.8, .8, .9, .9), var_ux = c(.02, .03, .04, .05),
rrx_restricted = c(TRUE, TRUE, FALSE, FALSE),
rrx_as_qx = c(TRUE, FALSE, TRUE, FALSE))

estimate_var_ux(rxx = c(.8, .85, .9, .95), var_rxx = 0,
ux = c(.8, .8, .9, .9), var_ux = c(.02, .03, .04, .05),
rrx_restricted = c(TRUE, TRUE, FALSE, FALSE),
rrx_as_qx = c(TRUE, FALSE, TRUE, FALSE))
```
Non-linear estimate of variance of $\rho$ corrected for psychometric artifacts using numeric integration

Description

Functions to estimate the variance of $\rho$ corrected for psychometric artifacts. These functions integrate over the residual distribution of correlations from an interactive artifact-distribution meta-analysis to non-linearly estimate the variance of $\rho$.

Available functions include:

- `estimate_var_rho_int_meas`
  Variance of $\rho$ corrected for measurement error only

- `estimate_var_rho_int_uvdrr`
  Variance of $\rho$ corrected for univariate direct range restriction (i.e., Case II) and measurement error

- `estimate_var_rho_int_bvdrr`
  Variance of $\rho$ corrected for bivariate direct range restriction and measurement error

- `estimate_var_rho_int_uvirr`
  Variance of $\rho$ corrected for univariate indirect range restriction (i.e., Case IV) and measurement error

- `estimate_var_rho_int_bvirr`
  Variance of $\rho$ corrected for bivariate indirect range restriction (i.e., Case V) and measurement error

- `estimate_var_rho_int_rb`
  Variance of $\rho$ corrected using Raju and Burke’s correction for direct range restriction and measurement error

Usage

```r
estimate_var_rho_int_meas(mean_qx, mean_qy, var_res)

estimate_var_rho_int_uvdrr(
  mean_rxyi,
  mean_rtpa,
  mean_qxa,
  mean_qyi,
  mean_ux,
  var_res
)
```
\begin{verbatim}
estimate_var_rho_int_uvirr(
    mean_rxyi,
    mean_rtpa,
    mean_qxi,
    mean_qyi,
    mean_ut,
    var_res
)

estimate_var_rho_int_bvirr(mean_qxa, mean_qya, mean_ux, mean_uy, var_res)

estimate_var_rho_int_bvdr(
    mean_rxyi,
    mean_rtpa,
    mean_qxa,
    mean_qya,
    mean_ux,
    mean_uy,
    var_res
)

estimate_var_rho_int_rb(
    mean_rxyi,
    mean_rtpa,
    mean_qx,
    mean_qy,
    mean_ux,
    var_res
)

\textbf{Arguments}

\begin{itemize}
    \item \textbf{mean_qx} Mean square root of reliability for X.
    \item \textbf{mean_qy} Mean square root of reliability for Y.
    \item \textbf{var_res} Residual variance from an interative artifact distribution (i.e., variance of observed correlations minus predicted error variance and predicted artifact variance).
    \item \textbf{mean_rxyi} Mean observed correlation.
    \item \textbf{mean_rtpa} Mean corrected correlation.
    \item \textbf{mean_qxa} Mean square root of unrestricted reliability for X.
    \item \textbf{mean_qya} Mean square root of restricted reliability for Y.
    \item \textbf{mean_ux} Mean observed-score u ratio for X.
    \item \textbf{mean_qxi} Mean square root of restricted reliability for X.
    \item \textbf{mean_ut} Mean true-score u ratio for X.
    \item \textbf{mean_qyi} Mean square root of unrestricted reliability for Y.
    \item \textbf{mean_uy} Mean observed-score u ratio for Y.
\end{itemize}
\end{verbatim}
**Value**

A vector of non-linear estimates of the variance of rho.

**Notes**

estimate_var_rho_int_meas and estimate_var_rho_int_bvirr do not make use of numeric integration because they are linear functions.

**References**


### Description

Functions to estimate the variance of $\rho$ corrected for psychometric artifacts. These functions use Taylor series approximations (i.e., the delta method) to estimate the variance in observed effect sizes predictable from the variance in artifact distributions based on the partial derivatives.

The available Taylor-series functions include:

- **estimate_var_rho_tsa_meas**
  Variance of $\rho$ corrected for measurement error only

- **estimate_var_rho_tsa_uvdr**
  Variance of $\rho$ corrected for univariate direct range restriction (i.e., Case II) and measurement error

- **estimate_var_rho_tsa_bvdr**
  Variance of $\rho$ corrected for bivariate direct range restriction and measurement error

- **estimate_var_rho_tsa_uvire**
  Variance of $\rho$ corrected for univariate indirect range restriction (i.e., Case IV) and measurement error

- **estimate_var_rho_tsa_bvire**
  Variance of $\rho$ corrected for bivariate indirect range restriction (i.e., Case V) and measurement error

- **estimate_var_rho_tsa_rb1**
  Variance of $\rho$ corrected using Raju and Burke’s TSA1 correction for direct range restriction and measurement error

- **estimate_var_rho_tsa_rb2**
  Variance of $\rho$ corrected using Raju and Burke’s TSA2 correction for direct range restriction and measurement error. Note that a typographical error in Raju and Burke’s article has been corrected in this function so as to compute appropriate partial derivatives.
Usage

```r
estimate_var_rho_tsa_meas(
    mean_rtp,
    var_rxy,
    var_e,
    mean_qx = 1,
    var_qx = 0,
    mean_qy = 1,
    var_qy = 0,
    ...
)

estimate_var_rho_tsa_uvdrr(
    mean_rtpa,
    var_rxyi,
    var_e,
    mean_ux = 1,
    var_ux = 0,
    mean_qxa = 1,
    var_qxa = 0,
    mean_qyi = 1,
    var_qyi = 0,
    ...
)

estimate_var_rho_tsa_bvdrr(
    mean_rtpa,
    var_rxyi,
    var_e = 0,
    mean_ux = 1,
    var_ux = 0,
    mean_uy = 1,
    var_uy = 0,
    mean_qxa = 1,
    var_qxa = 0,
    mean_qya = 1,
    var_qya = 0,
    ...
)

estimate_var_rho_tsa_uvirr(
    mean_rtpa,
    var_rxyi,
    var_e,
    mean_ut = 1,
    var_ut = 0,
    mean_qxa = 1,
    var_qxa = 0,
    ...
)
```
mean_qyi = 1,
var_qyi = 0,
...
)

estimate_var_rho_tsa_bvirr(
    mean_rtpa,
    var_rxyi,
    var_e = 0,
    mean_ux = 1,
    var_ux = 0,
    mean_uy = 1,
    var_uy = 0,
    mean_qxa = 1,
    var_qxa = 0,
    mean_qya = 1,
    var_qya = 0,
    sign_rxz = 1,
    sign_ryz = 1,
    ...
)

estimate_var_rho_tsa_rb1(
    mean_rtpa,
    var_rxyi,
    var_e,
    mean_ux = 1,
    var_ux = 0,
    mean_rxx = 1,
    var_rxx = 0,
    mean_ryy = 1,
    var_ryy = 0,
    ...
)

estimate_var_rho_tsa_rb2(
    mean_rtpa,
    var_rxyi,
    var_e,
    mean_ux = 1,
    var_ux = 0,
    mean_qx = 1,
    var_qx = 0,
    mean_qy = 1,
    var_qy = 0,
    ...
)
estimate_var_rho_tsa

Arguments

- mean_rtp: Mean corrected correlation.
- var_rxy: Variance of observed correlations.
- var_e: Error variance of observed correlations
- mean_qx: Mean square root of reliability for X.
- var_qx: Variance of square roots of reliability estimates for X.
- mean_qy: Mean square root of reliability for Y.
- var_qy: Variance of square roots of reliability estimates for Y.
- ... Additional arguments.
- mean_rtpa: Mean corrected correlation.
- var_rxyi: Variance of observed correlations.
- mean_ux: Mean observed-score u ratio for X.
- var_ux: Variance of observed-score u ratios for X.
- mean_qxa: Mean square root of unrestricted reliability for X.
- var_qxa: Variance of square roots of unrestricted reliability estimates for X.
- mean_qyi: Mean square root of restricted reliability for Y.
- var_qyi: Variance of square roots of restricted reliability estimates for Y.
- mean_uy: Mean observed-score u ratio for Y.
- var_uy: Variance of observed-score u ratios for Y.
- mean_qya: Mean square root of unrestricted reliability for Y.
- var_qya: Variance of square roots of unrestricted reliability estimates for Y.
- mean_ut: Mean true-score u ratio for X.
- var_ut: Variance of true-score u ratios for X.
- sign_rxz: Sign of the relationship between X and the selection mechanism.
- sign_ryz: Sign of the relationship between Y and the selection mechanism.
- mean_rxx: Mean reliability for X.
- var_rxx: Variance of reliability estimates for X.
- mean_ryy: Mean reliability for Y.
- var_ryy: Variance of reliability estimates for Y.

Details

######## Measurement error only ########
The attenuation formula for measurement error is

\[ \rho_{XY} = \rho_{TP} q_X q_Y \]

where \( \rho_{XY} \) is an observed correlation, \( \rho_{TP} \) is a true-score correlation, and \( q_X \) and \( q_Y \) are the square roots of reliability coefficients for X and Y, respectively.
The Taylor series approximation of the variance of $\rho_{TP}$ can be computed using the following linear equation,

$$\text{var}_{\rho_{TP}} \approx \left[ \text{var}_{r_{XY}} - \text{var}_e - (b_1^2 \text{var}_{q_X} + b_2^2 \text{var}_{q_Y}) \right] / b_3^2$$

where $b_1, b_2,$ and $b_3$ are first-order partial derivatives of the attenuation formula with respect to $q_X, q_Y,$ and $\rho_{TP},$ respectively. The first-order partial derivatives of the attenuation formula are:

$$b_1 = \frac{\partial \rho_{XY}}{\partial q_X} = \rho_{TP} q_Y$$

$$b_2 = \frac{\partial \rho_{XY}}{\partial q_Y} = \rho_{TP} q_X$$

$$b_3 = \frac{\partial \rho_{XY}}{\partial \rho_{TP}} = q_X q_Y$$

Univariate direct range restriction (UVDRR; i.e., Case II)

The UVDRR attenuation procedure may be represented as

$$\rho_{XY_i} = \frac{\rho_{TP} q_Y q_{X_a} u_X}{\sqrt{\rho_{TP} q_{X_a}^2 (u_X^2 - 1) + 1}}$$

The attenuation formula can also be represented as:

$$\rho_{XY_i} = \rho_{TP} q_Y q_{X_a} u_X A$$

where

$$A = \frac{1}{\sqrt{\rho_{TP} q_{X_a}^2 (u_X^2 - 1) + 1}}$$

The Taylor series approximation of the variance of $\rho_{TP_a}$ can be computed using the following linear equation,

$$\text{var}_{\rho_{TP_a}} \approx \left[ \text{var}_{r_{XY_i}} - \text{var}_e - (b_1^2 \text{var}_{q_{X_a}} + b_2^2 \text{var}_{q_Y_i} + b_3^2 \text{var}_{u_X}) \right] / b_4^2$$

where $b_1, b_2, b_3,$ and $b_4$ are first-order partial derivatives of the attenuation formula with respect to $q_{X_a}, q_Y_i, u_X,$ and $\rho_{TP_a},$ respectively. The first-order partial derivatives of the attenuation formula are:

$$b_1 = \frac{\partial \rho_{XY_i}}{\partial q_{X_a}} = \rho_{TP_a} q_Y q_{X_a} u_X A^3$$

$$b_2 = \frac{\partial \rho_{XY_i}}{\partial q_{Y_i}} = \frac{\rho_{XY_i}}{q_{Y_i}}$$

$$b_3 = \frac{\partial \rho_{XY_i}}{\partial u_X} = -\rho_{TP_a} q_Y q_{X_a} \left( \rho_{TP_a} q_{X_a}^2 - 1 \right) A^3$$
\[ b_4 = \frac{\partial \rho_{XY}}{\partial \rho_{TP_a}} = q_Y q_{X_a} u_X A^3 \]

Univariate indirect range restriction (UVIRR; i.e., Case IV)

Under univariate indirect range restriction, the attenuation formula yielding \( \rho_{XY_i} \) is:

\[ \rho_{XY_i} = \frac{u_T q_{X_a}}{\sqrt{u_T^2 q_{X_a}^2 + 1 - q_{X_a}^2}} \frac{u_T \rho_{TP_a}}{\sqrt{u_T^2 \rho_{TP_a}^2 + 1 - \rho_{TP_a}^2}} \]

The attenuation formula can also be represented as:

\[ \rho_{XY_i} = q_{X_a} q_Y \rho_{TP_a} u_T^2 AB \]

where

\[ A = \frac{1}{\sqrt{u_T^2 q_{X_a}^2 + 1 - q_{X_a}^2}} \]

and

\[ B = \frac{1}{\sqrt{u_T^2 \rho_{TP_a}^2 + 1 - \rho_{TP_a}^2}} \]

The Taylor series approximation of the variance of \( \rho_{TP_a} \) can be computed using the following linear equation,

\[ \text{var}_{\rho_{TP_a}} \approx \frac{\text{var}_{\rho_{XY_i}} - \text{var}_e - (b_1^2 \text{var}_{q_{X_a}} + b_2^2 \text{var}_{q_Y} + b_3^2 \text{var}_{u_T})}{b_4^2} \]

where \( b_1, b_2, b_3, \) and \( b_4 \) are first-order partial derivatives of the attenuation formula with respect to \( q_{X_a}, q_Y, u_T, \) and \( \rho_{TP_a} \), respectively. The first-order partial derivatives of the attenuation formula are:

\[ b_1 = \frac{\partial \rho_{XY_i}}{\partial q_{X_a}} = \frac{\rho_{XY_i}}{q_{X_a}} - \rho_{XY_i} q_{X_a} B^2 (u_T^2 - 1) \]

\[ b_2 = \frac{\partial \rho_{XY_i}}{\partial q_Y} = \frac{\rho_{XY_i}}{q_Y} \]

\[ b_3 = \frac{\partial \rho_{XY_i}}{\partial u_T} = \frac{2 \rho_{XY_i}}{u_T} - \rho_{XY_i} u_T q_{X_a} B^2 - \rho_{XY_i} u_T \rho_{TP_a}^2 A^2 \]

\[ b_4 = \frac{\partial \rho_{XY_i}}{\partial \rho_{TP_a}} = \frac{\rho_{XY_i}}{\rho_{TP_a}} - \rho_{XY_i} \rho_{TP_a} A^2 (u_T^2 - 1) \]

Bivariate direct range restriction (BVDRR)

Under bivariate direct range restriction, the attenuation formula yielding \( \rho_{XY_i} \) is:
\[
\rho_{XY_i} = \frac{A + \rho_{TP_i}^2 q_{X_a} q_{Y_a} - \frac{1}{q_{X_a} q_{Y_a}}}{2 \rho_{TP_a} u_X u_Y}
\]

where

\[
A = \sqrt{\left(\frac{1}{q_{X_a} q_{Y_a}} - \rho_{TP_a}^2 q_{X_a} q_{Y_a}\right)^2 + 4 \rho_{TP_a} u_X^2 u_Y^2}
\]

The Taylor series approximation of the variance of \( \rho_{TP_a} \) can be computed using the following linear equation,

\[
\text{var}_{\rho_{TP_a}} \approx \left[ \text{var}_{r_{XY_i}} - \text{var}_{e} - (b_1^2 \text{var}_{q_{X_a}} + b_2^2 \text{var}_{q_{Y_i}} + b_3^2 \text{var}_{u_X} + b_4^2 \text{var}_{u_Y}) \right] / b_5^2
\]

where \( b_1, b_2, b_3, b_4, \) and \( b_5 \) are first-order partial derivatives of the attenuation formula with respect to \( q_{X_a}, q_{Y_a}, u_X, u_Y, \) and \( \rho_{TP_a} \), respectively. First, we define terms to simplify the computation of partial derivatives:

\[
B = \left( \rho_{TP_a}^2 q_{X_a}^2 q_{Y_a}^2 + q_{X_a} q_{Y_a} A - 1 \right)
\]

\[
C = 2 \rho_{TP_a}^2 q_{X_a}^2 q_{Y_a}^2 u_X u_Y A
\]

The first-order partial derivatives of the attenuation formula are:

\[
b_1 = \frac{\partial \rho_{XY_i}}{\partial q_{X_a}} = \frac{\left( \rho_{TP_a}^2 q_{X_a}^2 q_{Y_a}^2 + 1 \right) B}{q_{X_a} C}
\]

\[
b_2 = \frac{\partial \rho_{XY_i}}{\partial q_{Y_i}} = \frac{\left( \rho_{TP_a}^2 q_{X_a}^2 q_{Y_a}^2 + 1 \right) B}{q_{Y_a} C}
\]

\[
b_3 = \frac{\partial \rho_{XY_i}}{\partial u_X} = -\frac{(\rho_{TP_a} q_{X_a} q_{Y_a} - 1) (\rho_{TP_a} q_{X_a} q_{Y_a} + 1) B}{u_X C}
\]

\[
b_4 = \frac{\partial \rho_{XY_i}}{\partial u_Y} = -\frac{(\rho_{TP_a} q_{X_a} q_{Y_a} - 1) (\rho_{TP_a} q_{X_a} q_{Y_a} + 1) B}{u_Y C}
\]

\[
b_5 = \frac{\partial \rho_{XY_i}}{\partial \rho_{TP_a}} = \frac{\left( \rho_{TP_a}^2 q_{X_a}^2 q_{Y_a}^2 + 1 \right) B}{\rho_{TP_a} C}
\]

Bivariate indirect range restriction (BIVRR; i.e., Case V) #Bivariate indirect range restriction (BIVRR; i.e., Case V)#

Under bivariate indirect range restriction, the attenuation formula yielding \( \rho_{XY_i} \) is:

\[
\rho_{XY_i} = \frac{\rho_{TP_a} q_{X_a} q_{Y_a} - \lambda \sqrt{1 - u_X^2} \sqrt{1 - u_Y^2}}{u_X u_Y}
\]

The Taylor series approximation of the variance of \( \rho_{TP_a} \) can be computed using the following linear equation,
\[ var_{\rho_{TPa}} \approx \left[ var_{\rho_{XYi}} - \var_e - \left( b_1^2 \text{var}_{\rho_{Xa}} + b_2^2 \text{var}_{\rho_{Ya}} + b_3^2 \text{var}_{u_X} + b_4^2 \text{var}_{u_Y} \right) \right] / b_5^2 \]

where \( b_1, b_2, b_3, b_4, \) and \( b_5 \) are first-order partial derivatives of the attenuation formula with respect to \( q_{Xa}, q_{Ya}, u_X, u_Y, \) and \( \rho_{TPa} \), respectively. First, we define terms to simplify the computation of partial derivatives:

\[
\begin{align*}
  b_1 &= \frac{\partial \rho_{XYi}}{\partial q_{Xa}} = \frac{\rho_{TPa} q_{Ya}}{u_X u_Y} \\
  b_2 &= \frac{\partial \rho_{XYi}}{\partial q_{Ya}} = \frac{\rho_{TPa} q_{Xa}}{u_X u_Y} \\
  b_3 &= \frac{\partial \rho_{XYi}}{\partial u_X} = \frac{\lambda \left(1 - u_X^2 \right)}{u_Y |1 - u_X^2|^{1.5}} - \frac{\rho_{XYi}}{u_X} \\
  b_4 &= \frac{\partial \rho_{XYi}}{\partial u_Y} = \frac{\lambda \left(1 - u_Y^2 \right)}{u_X |1 - u_Y^2|^{1.5}} - \frac{\rho_{XYi}}{u_Y} \\
  b_5 &= \frac{\partial \rho_{XYi}}{\partial \rho_{TPa}} = \frac{q_{Xa} q_{Ya}}{u_X u_Y}
\end{align*}
\]

######## Raju and Burke’s TSA1 procedure ########

Raju and Burke’s attenuation formula may be represented as

\[
\rho_{XYi} = \frac{\rho_{TPa} u_X \sqrt{\rho_{XXa} \rho_{YYa}}}{\sqrt{\rho_{TPa}^2 \rho_{XXa} \rho_{YYa} u_X^2 - \rho_{TPa}^2 \rho_{XXa} \rho_{YYa} + 1}}
\]

The Taylor series approximation of the variance of \( \rho_{TPa} \) can be computed using the following linear equation,

\[ var_{\rho_{TPa}} \approx \left[ var_{\rho_{XYi}} - \var_e - \left( B^2 \text{var}_{\rho_{YYa}} + C^2 \text{var}_{\rho_{XXa}} + D^2 \text{var}_{u_X} \right) \right] / A^2 \]

where \( A, B, C, \) and \( D \) are first-order partial derivatives of the attenuation formula with respect to \( \rho_{TPa}, \rho_{XXa}, \rho_{YYa}, \) and \( u_X, \) respectively. The first-order partial derivatives of the attenuation formula are:

\[
\begin{align*}
  A &= \frac{\partial \rho_{XYi}}{\partial \rho_{TPa}} = \frac{\rho_{XYi}}{\rho_{TPa}} + \frac{\rho_{XYi}^3(1-u_X^2)}{\rho_{TPa} u_X^3} \\
  B &= \frac{\partial \rho_{XYi}}{\partial \rho_{YYa}} = \frac{1}{2} \left( \frac{\rho_{XYi}}{\rho_{YYa}} + \frac{\rho_{XYi}^3(1-u_X^2)}{\rho_{YYa} u_X^3} \right) \\
  C &= \frac{\partial \rho_{XYi}}{\partial \rho_{XXa}} = \frac{1}{2} \left( \frac{\rho_{XYi}}{\rho_{XXa}} + \frac{\rho_{XYi}^3(1-u_X^2)}{\rho_{XXa} u_X^3} \right)
\end{align*}
\]
$$D = \frac{\partial \rho_{XY_i}}{\partial u_X} = \frac{\rho_{XY_i} - \rho_{3XY_i}^2}{u_X}$$

################ Raju and Burke’s TSA2 procedure ################

Raju and Burke’s attenuation formula may be represented as

$$\rho_{XY_i} = \frac{\rho_{TP_a,q_X,q_Y u_X}}{\sqrt{\rho_{TP_a,q_X,q_Y u_X}^2 - \rho_{TP_a,q_X,q_Y u_X}^2 + 1}}$$

The Taylor series approximation of the variance of $\rho_{TP_a}$ can be computed using the following linear equation,

$$\text{var}_{\rho_{TP_a}} \approx \left[ \text{var}_{r_{XY_i}} - \text{var}_e - \left( F^2 \text{var}_{q_{Y_a}} + G^2 \text{var}_{q_{X_a}} + H^2 \text{var}_{u_X} \right) \right] / E^2$$

where E, F, G, and H are first-order partial derivatives of the attenuation formula with respect to $\rho_{TP_a}$, $q_{X_a}$, $q_{Y_a}$, and $u_X$, respectively. The first-order partial derivatives of the attenuation formula (with typographic errors in the original article corrected) are:

$$E = \frac{\partial \rho_{XY_i}}{\partial \rho_{TP_a}} = \frac{\rho_{XY_i}}{\rho_{TP_a}} + \frac{\rho_{3XY_i} (1-u_X^2)}{\rho_{TP_a} u_X^2}$$

$$F = \frac{\partial \rho_{XY_i}}{\partial q_{Y_a}} = \frac{\rho_{XY_i}}{q_{Y_a}} + \frac{\rho_{3XY_i} (1-u_X^2)}{q_{Y_a} u_X^2}$$

$$G = \frac{\partial \rho_{XY_i}}{\partial q_{X_a}} = \frac{\rho_{XY_i}}{q_{X_a}} + \frac{\rho_{3XY_i} (1-u_X^2)}{q_{X_a} u_X^2}$$

$$H = \frac{\partial \rho_{XY_i}}{\partial u_X} = \frac{\rho_{XY_i} - \rho_{3XY_i}^2}{u_X}$$

Value

Vector of meta-analytic variances estimated via Taylor series approximation.

Notes

A typographical error in Raju and Burke’s article has been corrected in estimate_var_rho_tsa_rb2 so as to compute appropriate partial derivatives.

References

Dahlke, J. A., & Wiernik, B. M. (2018). One of these artifacts is not like the others: Accounting for indirect range restriction in organizational and psychological research. Manuscript submitted for review.


estimate_var_tsa

Taylor Series Approximation of effect-size variances corrected for psychometric artifacts

Description

Functions to estimate the variances corrected for psychometric artifacts. These functions use Taylor series approximations (i.e., the delta method) to estimate the corrected variance of an effect-size distribution.

The available Taylor-series functions include:

- **estimate_var_tsa_meas**
  Variance of $\rho$ corrected for measurement error only

- **estimate_var_tsa_uvdrr**
  Variance of $\rho$ corrected for univariate direct range restriction (i.e., Case II) and measurement error

Examples

```r
estimate_var_rho_tsa_meas(mean_rtp = .5, var_rxy = .02, var_e = .01, 
mean_qx = .8, var_qx = .005, 
mean_qy = .8, var_qy = .005)
estimate_var_rho_tsa_uvdrr(mean_rtpa = .5, var_rxyi = .02, var_e = .01, 
mean_ux = .8, var_ux = .005, 
mean_qxa = .8, var_qxa = .005, 
mean_qyi = .8, var_qyi = .005)
estimate_var_rho_tsa_bvdrr(mean_rtpa = .5, var_rxyi = .02, var_e = .01, 
mean_ux = .8, var_ux = .005, 
mean_qx = .8, var_qx = .005, 
mean_qy = .8, var_qy = .005, 
mean_qya = .8, var_qya = .005)
estimate_var_rho_tsa_uvirr(mean_rtpa = .5, var_rxyi = .02, var_e = .01, 
mean_ut = .8, var_ut = .005, 
mean_qxa = .8, var_qxa = .005, 
mean_qyi = .8, var_qyi = .005)
estimate_var_rho_tsa_bvirr(mean_rtpa = .5, var_rxyi = .02, var_e = .01, 
mean_ux = .8, var_ux = .005, 
mean_qx = .8, var_qx = .005, 
mean_qy = .8, var_qy = .005, 
mean_qya = .8, var_qya = .005, 
sign_rxz = 1, sign_ryz = 1)
estimate_var_rho_tsa_rb1(mean_rtpa = .5, var_rxyi = .02, var_e = .01, 
mean_ux = .8, var_ux = .005, 
mean_rxx = .8, var_rxx = .005, 
mean_ryy = .8, var_ryy = .005)
estimate_var_rho_tsa_rb2(mean_rtpa = .5, var_rxyi = .02, var_e = .01, 
mean_ux = .8, var_ux = .005, 
mean_qx = .8, var_qx = .005, 
mean_qy = .8, var_qy = .005)
```
• `estimate_var_tsa_bvdr`  
  Variance of $\rho$ corrected for bivariate direct range restriction and measurement error  
• `estimate_var_tsa_uvdr`  
  Variance of $\rho$ corrected for univariate indirect range restriction (i.e., Case IV) and measurement error  
• `estimate_var_tsa_bvdr`  
  Variance of $\rho$ corrected for bivariate indirect range restriction (i.e., Case V) and measurement error  
• `estimate_var_tsa_rb1`  
  Variance of $\rho$ corrected using Raju and Burke’s TSA1 correction for direct range restriction and measurement error  
• `estimate_var_tsa_rb2`  
  Variance of $\rho$ corrected using Raju and Burke’s TSA2 correction for direct range restriction and measurement error. Note that a typographical error in Raju and Burke’s article has been corrected in this function so as to compute appropriate partial derivatives.

**Usage**

```r
estimate_var_tsa_meas(mean_rtp, var = 0, mean_qx = 1, mean_qy = 1, ...)  
estimate_var_tsa_uvdrr(  
  mean_rtpa,  
  var = 0,  
  mean_ux = 1,  
  mean_qxa = 1,  
  mean_qyi = 1,  
  ...)  
)  
estimate_var_tsa_bvdrr(  
  mean_rtpa,  
  var = 0,  
  mean_ux = 1,  
  mean_uy = 1,  
  mean_qxa = 1,  
  mean_qya = 1,  
  ...)  
)  
estimate_var_tsa_uvirr(  
  mean_rtpa,  
  var = 0,  
  mean_ut = 1,  
  mean_qxa = 1,  
  mean_qyi = 1,  
  ...)  
)  
```
estimate_var_tsa_bvirr(
    mean_rtpa,
    var = 0,
    mean_ux = 1,
    mean_uy = 1,
    mean_qxa = 1,
    mean_qya = 1,
    sign_rxz = 1,
    sign_ryz = 1,
    ...
)

estimate_var_tsa_rb1(
    mean_rtpa,
    var = 0,
    mean_ux = 1,
    mean_rxx = 1,
    mean_ryy = 1,
    ...
)

estimate_var_tsa_rb2(
    mean_rtpa,
    var = 0,
    mean_ux = 1,
    mean_qx = 1,
    mean_qy = 1,
    ...
)

Arguments

- **mean_rtp**  Mean corrected correlation.
- **var**      Variance to be corrected for artifacts.
- **mean_qx**  Mean square root of reliability for X.
- **mean_qy**  Mean square root of reliability for Y.
- **...**      Additional arguments.
- **mean_rtpa** Mean corrected correlation.
- **mean_ux**  Mean observed-score u ratio for X.
- **mean_qxa** Mean square root of unrestricted reliability for X.
- **mean_qyi** Mean square root of restricted reliability for Y.
- **mean_uy**  Mean observed-score u ratio for Y.
- **mean_qya** Mean square root of unrestricted reliability for Y.
- **mean_ut**  Mean true-score u ratio for X.
- **sign_rxz** Sign of the relationship between X and the selection mechanism.
sign_ryz  Sign of the relationship between Y and the selection mechanism.
mean_rxx  Mean reliability for X.
mean_ryy  Mean reliability for Y.

Value
Vector of variances corrected for mean artifacts via Taylor series approximation.

Notes
A typographical error in Raju and Burke’s article has been corrected in estimate_var_tsa_rb2 so as to compute appropriate partial derivatives.

References
Dahlke, J. A., & Wiernik, B. M. (2018). *One of these artifacts is not like the others: Accounting for indirect range restriction in organizational and psychological research*. Manuscript submitted for review.


Examples
```r
estimate_var_tsa_meas(mean_rtp = .5, var = .02,
                       mean_qx = .8,
                       mean_qy = .8)

estimate_var_tsa_uvdr(mean_rtpa = .5, var = .02,
                       mean_ux = .8,
                       mean_qxa = .8,
                       mean_qyi = .8)

estimate_var_tsa_bvdr(mean_rtpa = .5, var = .02,
                       mean_ux = .8,
                       mean_uy = .8,
                       mean_qxa = .8,
                       mean_qya = .8)

estimate_var_tsa_uvir(mean_rtpa = .5, var = .02,
                       mean_ut = .8,
                       mean_qxa = .8,
                       mean_qyi = .8)

estimate_var_tsa_bvir(mean_rtpa = .5, var = .02,
                       mean_ux = .8,
                       mean_uy = .8,
                       mean_qxa = .8,
                       mean_qya = .8,
                       sign_rxz = 1, sign_ryz = 1)

estimate_var_tsa_rb1(mean_rtpa = .5, var = .02,
```

filter_ma

mean_ux = .8,
mean_rxx = .8,
mean_ryy = .8)
estimate_var_tsa_rb2(mean_rtpa = .5, var = .02,
mean_ux = .8,
mean_qx = .8,
mean_qy = .8)

filter_ma

Filter meta-analyses

Description

Filter psychmeta meta-analysis objects based on specified criteria.

Usage

filter_ma(
  ma_obj,
  analyses = "all",
  match = c("all", "any"),
  case_sensitive = TRUE,
  ...
)
filter_meta(
  ma_obj,
  analyses = "all",
  match = c("all", "any"),
  case_sensitive = TRUE,
  ...
)

Arguments

ma_obj A psychmeta meta-analysis object.
analyses Which analyses to extract? Can be either "all" to extract all meta-analyses in the object (default) or a list containing one or more of the following arguments:
  • construct: A list or vector of construct names to search for.
  • construct_pair: A list of vectors of construct pairs to search for.
    (e.g., list(c("X","Y"),c("X","Z"))).
  • pair_id: A list or vector of numeric construct pair IDs (unique construct-pair indices).
  • analysis_id: A list or vector of numeric analysis IDs (unique analysis indexes).
  • k_min: A numeric value specifying the minimum k for extracted meta-analyses.
• N_min: A numeric value specifying the minimum N for extracted meta-analyses.

match Should extracted meta-analyses match all (default) or any of the criteria given in analyses?

case_sensitive Logical scalar that determines whether character values supplied in analyses should be treated as case sensitive (TRUE, default) or not (FALSE).

... Additional arguments.

Value

A psychmeta meta-analysis object with analyses matching the specified criteria.

Examples

ma_obj <- ma_r(ma_method = "ic", rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi, construct_x = x_name, construct_y = y_name, sample_id = sample_id, citekey = NULL, moderators = moderator, data = data_r_meas_multi, impute_artifacts = FALSE, clean_artifacts = FALSE)

ma_obj <- ma_r_ad(ma_obj, correct_rr_x = FALSE, correct_rr_y = FALSE)

filter_ma(ma_obj, analyses="all")

filter_ma(ma_obj, analyses=list(construct="X"), match="all")

filter_ma(ma_obj, analyses=list(construct="X", k_min=21), match="any")

filter_ma(ma_obj, analyses=list(construct="X", k_min=21), match="all")

---

**Description**

A function to format numbers and logical values as characters for display purposes. Includes control over formatting of decimal digits, leading zeros, sign characters, and characters to replace logical, NA, NaN, and Inf values. Factors are converted to strings. Strings are returned verbatim.

**Usage**

format_num(x, digits = 2L, decimal.mark =getOption("OutDec"), leading0 = "conditional", drop0integer = FALSE, neg.sign = "\u2212", pos.sign = "figure", big.mark = "\u202F", big.interval = 3L, small.mark = "\u202F", small.interval = 3L, na.mark = "\u2014", lgl.mark = c("+", "\u2212"), inf.mark = c("+\u221E", "\u2212\u221E") )
Arguments

- **x**: A vector, matrix, or data.frame of numbers to format.
- **digits**: The number of decimal digits desired (used strictly; default: 2).
- **decimal.mark**: The character to use for the decimal point (defaults to locale default: getOption("OutDec")).
- **leading0**: How to print leading zeros on decimals. Can be logical to print (TRUE) or suppress (FALSE) leading zeros or a character string to substitute for leading zeros. If "conditional" (default), leading zeros are shown if a column contains any absolute values greater than 1 and suppressed otherwise. If "figure", leading zeros are replaced with a figure space (U+2007) if a column contains any absolute values greater than 1 and suppressed otherwise. If "figure_html", the same as "figure", but using the HTML entity for figure space (useful for Windows users in some locales).
- **drop0integer**: Logical. Should trailing decimal zeros be dropped for integers?
- **neg.sign**: Character to use as negative sign. Defaults to minus-sign (U+2212).
- **pos.sign**: Character to use as positive sign. Set to FALSE to suppress. If "figure" (default), the positive sign is a figure-space (U+2007) if a column contains any negative numbers and suppressed otherwise. If "figure_html", the same as "figure", but using the HTML entity for figure space (useful for Windows users in some locales).
- **big.mark**: Character to mark between each big.interval digits before the decimal point. Set to FALSE to suppress. Defaults to the SI/ISO 31-0 standard recommended thin-spaces (U+202F).
- **big.interval**: See big.mark above; defaults to 3.
- **small.mark**: Character to mark between each small.interval digits after the decimal point. Set to FALSE to suppress. Defaults to the SI/ISO 31-0 standard recommended thin-spaces (U+202F).
- **small.interval**: See small.mark above; defaults to 3.
- **na.mark**: Character to replace NA and NaN values. Defaults to em-dash (U+2014)
- **lgl.mark**: A length 2 vector containing characters to replace TRUE and FALSE. Defaults to c("+", "U+2212").
- **inf.mark**: A length 2 vector containing characters to replace Inf and -Inf. Defaults to c("+U+221e", "U+2212U+221e").

Examples

# format_num() converts numeric values to characters with the specified formatting options. # By default, thousands digit groups are separated by thin spaces, negative signs are replaced # with minus signs, and positive signs and leading zeros are replaced with figure spaces # (which have the same width as numbers and minus signs). These options ensure that all # results will align neatly in columns when tabulated. format_num(x = c(10000, 1000, 2.41, -1.20, 0.41, -0.20))

# By default, format_num() uses your computer locale's default decimal mark as # the decimal point. To force the usage of "." instead (e.g., for submission to # a U.S. journal), set decimal.mark = ".":
generate_bib

Generate a list of references included in meta-analyses

Description

This function generates a list of studies contributing to a meta-analysis.

Usage

```
generate_bib(
  ma_obj = NULL,
  bib = NULL,
  title.bib = NULL,
  style = "apa",
  additional_citekeys = NULL,
  file = NULL,
  output_dir = getwd(),
  output_format = c("word", "html", "pdf", "text", "odt", "rmd", "biblatex",
                   "citekeys"),
  analyses = "all",
  match = c("all", "any"),
  case_sensitive = TRUE,
  save_build_files = FALSE,
  header = list(),
  ...
)
```

Arguments

- **ma_obj** A psychmeta meta-analysis object with citekeys supplied.
- **bib** A BibTeX file containing the citekeys for the meta-analyses.
- **title.bib** The title to give to the bibliography. If NULL, defaults to "Sources Contributing to Meta-Analyses".
- **style** What style should references be formatted in? Can be a file path or URL for a CSL citation style or the style ID for any style available from the Zotero Style Repository. Defaults to APA style. (Retrieving a style by ID requires an internet connection. If unavailable, references will be rendered in Chicago style.).
generate_bib

additional_citekeys
Additional citekeys to include in the reference list.

file
The filename or filepath for the output file. If NULL, function will output directly to the R console (if output_format is "text", a tibble with basic citation information; if "citekeys", the citekeys for included sources; otherwise, code to generate the bibliography in an RMarkdown document).

output_dir
The filepath for the output file. Defaults to the current working directory.

output_format
The format of the output reference list. Available options are Word (default), HTML, PDF (requires LaTeX to be installed), ODT, or RMarkdown, plain text, and BibLaTeX. Returning only the item citekeys is also possible. You can also specify the full name of another RMarkdown output_format.

analyses
Which analyses to extract references for? See filter_ma for details.

match
Match all or any of the filter criteria? See filter_ma for details.

case_sensitive
Logical scalar that determines whether character values supplied in analyses should be treated as case sensitive (TRUE, default) or not (FALSE).

save_build_files
Should the BibTeX and RMarkdown files used to generate the bibliography be saved (default: FALSE; always TRUE if file is NULL)?

header
A list of YAML header parameters to pass to link<rmarkdown::render>.

Value
A list containing a tibble of bibtex reference data. Additionally, a reference list formatted in the requested style and output_format is exported (or printed if file is "console").

See Also
Other output functions: metabulate_rmd_helper(), metabulate()

Examples

### Not run:
### Run a meta-analysis using ma_r() and include a citekey argument to provide
citation information for each source contributing to the meta-analyses.
ma_obj <- ma_r(ma_method = "ic", rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi,
                 construct_x = x_name, construct_y = y_name, sample_id = sample_id,
                 moderators = moderator, citekey = citekey, data = data_r_meas_multi)

### Next, use generate_bib() to generate the bibliography for the retained studies.
### The bib argument is the BibTeX or BibLaTeX .bib file containing the full
### reference information for each of the citekeys included in the meta-analysis database.
genenerate_bib(ma_obj, bib = system.file("templates/sample_bibliography.bib", package="psychmeta"),
             file = "sample bibliography", output_dir = tempdir(), output_format = "word")

### End(Not run)
generate_directory  Generate a system of folders from a file path to a new directory

Description
This function is intended to be helpful in simulations when directories need to be created and named according to values that are used or created within the simulation.

Usage
generate_directory(path)

Arguments
path  The path to the directory to be created

Value
Creates a system of folders to a new directory.

get_stuff  Extract results from a psychmeta meta-analysis object

Description
Functions to extract specific results from a meta-analysis tibble. This family of functions harvests information from meta-analysis objects and returns it as lists or tibbles that are easily navigable. Available functions include:

- **get_stuff**
  Wrapper function for all other "get_" functions.

- **get_metatab**
  Retrieve list of meta-analytic tables.

- **get_ad**
  Retrieve list of artifact-distribution objects or a summary table of artifact descriptive statistics.

- **get_plots**
  Retrieve list of meta-analytic plots.

- **get_escalc**
  Retrieve list of escalc objects (i.e., effect-size data) for use with `metafor`.

- **get_metafor**
  Alias for `get_escalc`.

- **get_followup**
  Retrieve list of follow-up analyses.
get_leavelout
Retrieve list of leave-one-out meta-analyses (special case of get_followup).

get_cumulative
Retrieve list of cumulative meta-analyses (special case of get_followup).

get_bootstrap
Retrieve list of bootstrap meta-analyses (special case of get_followup).

get_metareg
Retrieve list of meta-regression analyses (special case of get_followup).

get_heterogeneity
Retrieve list of heterogeneity analyses (special case of get_followup).

get_matrix
Retrieve a tibble of matrices summarizing the relationships among constructs (only applicable to meta-analyses with multiple constructs).

Usage

get_stuff(
  ma_obj,
  analyses = "all",
  match = c("all", "any"),
  case_sensitive = TRUE,
  ma_method = c("bb", "ic", "ad"),
  correction_type = c("ts", "vgx", "vgy"),
  moderators = FALSE,
  as_ad_obj = TRUE,
  inputs_only = FALSE,
  ad_type = c("tsa", "int"),
  follow_up = c("heterogeneity", "leavelout", "cumulative", "bootstrap", "metareg"),
  plot_types = c("funnel", "forest", "leavelout", "cumulative"),
  ...
)

get_escalc(
  ma_obj,
  analyses = "all",
  match = c("all", "any"),
  case_sensitive = TRUE,
  moderators = TRUE,
  ...
)

get_metafor(
  ma_obj,
  analyses = "all",
  match = c("all", "any"),
case_sensitive = TRUE,
moderators = TRUE,
...
)

get_metatab(
    ma_obj,
    analyses = "all",
    match = c("all", "any"),
    case_sensitive = TRUE,
    ma_method = c("bb", "ic", "ad"),
correction_type = c("ts", "vgx", "vgy"),
...
)

get_ad(
    ma_obj,
    analyses = "all",
    match = c("all", "any"),
    case_sensitive = TRUE,
    ma_method = c("ad", "ic"),
ad_type = c("tsa", "int"),
as_ad_obj = FALSE,
inputs_only = FALSE,
...
)

get_followup(
    ma_obj,
    analyses = "all",
    match = c("all", "any"),
    case_sensitive = TRUE,
    follow_up = c("heterogeneity", "leave1out", "cumulative", "bootstrap", "metareg"),
...
)

get_heterogeneity(
    ma_obj,
    analyses = "all",
    match = c("all", "any"),
    case_sensitive = TRUE,
...
)

get_leave1out(
    ma_obj,
    analyses = "all",
    match = c("all", "any"),
    ...
get_cumulative(
    ma_obj,
    analyses = "all",
    match = c("all", "any"),
    case_sensitive = TRUE,
    ...
)

get_bootstrap(
    ma_obj,
    analyses = "all",
    match = c("all", "any"),
    case_sensitive = TRUE,
    ...
)

get_metareg(
    ma_obj,
    analyses = "all",
    match = c("all", "any"),
    case_sensitive = TRUE,
    ...
)

get_matrix(
    ma_obj,
    analyses = "all",
    match = c("all", "any"),
    case_sensitive = TRUE,
    ...
)

get_plots(
    ma_obj,
    analyses = "all",
    match = c("all", "any"),
    case_sensitive = TRUE,
    plot_types = c("funnel", "forest", "leave1out", "cumulative"),
    ...
)

Arguments

ma_obj A psychmeta meta-analysis object.
**what**
For the `get_stuff()` function only: Character scalar telling `get_stuff()` what to get. All suffixes from functions in the "get_" family can be passed as arguments to `what`: "metatab", "escalc", "metafor", "ad", "followup", "heterogeneity", "leave1out", "cumulative", "bootstrap", "metareg", "matrix", "plots"

**analyses**
Which analyses to extract? Can be either "all" to extract references for all meta-analyses in the object (default) or a list containing one or more of the following arguments:
- **construct**: A list or vector of construct names to search for.
- **construct_pair**: A list of vectors of construct pairs to search for.
  (e.g., `list(c("X", "Y"), c("X", "Z"))`)
- **pair_id**: A list or vector of numeric construct pair IDs (unique construct-pair indices).
- **analysis_id**: A list or vector of numeric analysis IDs (unique analysis indexes).
- **k_min**: A numeric value specifying the minimum k for extracted meta-analyses.
- **N_min**: A numeric value specifying the minimum N for extracted meta-analyses.

**match**
Should extracted meta-analyses match all (default) or any of the criteria given in `analyses`?

**case_sensitive**
Logical scalar that determines whether character values supplied in `analyses` should be treated as case sensitive (TRUE, default) or not (FALSE).

**ma_method**
Meta-analytic methods to be included. Valid options are: "bb", "ic", and "ad"

**correction_type**
Types of meta-analytic corrections to be included. Valid options are: "ts", "vgx", and "vgy"

**moderators**
Logical scalar that determines whether moderator variables should be included in escalc objects (TRUE; default) or not (FALSE).

**as_ad_obj**
Logical scalar that determines whether artifact information should be returned as artifact-distribution objects (TRUE) or a summary table of artifact-distribution descriptive statistics (FALSE; default).

**inputs_only**
Used only if **as_ad_obj** = TRUE: Logical scalar that determines whether artifact information should be returned as summaries of the raw input values (TRUE) or artifact values that may have been cross-corrected for range restriction and measurement error (FALSE; default).

**ad_type**
Used only if **ma_method** = "ic": Character value(s) indicating whether Taylor-series approximation artifact distributions ("tsa") and/or interactive artifact distributions ("int") should be retrieved.

**follow_up**
Vector of follow-up analysis names (options are: "heterogeneity", "leave1out", "cumulative", "bootstrap", "metareg").

**plot_types**
Vector of plot types (options are: "funnel", "forest", "leave1out", "cumulative"; multiple allowed).

... Additional arguments.
Value
Selected set of results.

Examples

```r
## Not run:
## Run meta-analysis:
ma_obj <- ma_r(ma_method = "ic", rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi,
construct_x = x_name, construct_y = y_name,
sample_id = sample_id, citekey = NULL,
moderators = moderator, data = data_r_meas_multi,
impute_artifacts = FALSE, clean_artifacts = FALSE)

## Run additional analyses:
ma_obj <- ma_r_ad(ma_obj, correct_rr_x = FALSE, correct_rr_y = FALSE)
ma_obj <- heterogeneity(ma_obj)
ma_obj <- sensitivity(ma_obj, boot_iter = 10, boot_ci_type = "norm")
ma_obj <- metareg(ma_obj)
ma_obj <- plot_funnel(ma_obj)
ma_obj <- plot_forest(ma_obj)

## View summary:
summary(ma_obj)

## Extract selected analyses:
get_metatab(ma_obj)
get_matrix(ma_obj)
get_escalc(ma_obj)
get_bootstrap(ma_obj)
get_cumulative(ma_obj)
get_leave1out(ma_obj)
get_heterogeneity(ma_obj)
get_metareg(ma_obj)
get_plots(ma_obj)
get_ad(ma_obj, ma_method = "ic", as_ad_obj = TRUE)
get_ad(ma_obj, ma_method = "ic", as_ad_obj = FALSE)

## Same extractions as above, but using get_stuff() and the "what" argument:
get_stuff(ma_obj, what = "metatab")
get_stuff(ma_obj, what = "matrix")
get_stuff(ma_obj, what = "escalc")
get_stuff(ma_obj, what = "bootstrap")
get_stuff(ma_obj, what = "cumulative")
get_stuff(ma_obj, what = "leave1out")
get_stuff(ma_obj, what = "heterogeneity")
get_stuff(ma_obj, what = "metareg")
get_stuff(ma_obj, what = "plots")

## End(Not run)
```
Supplemental heterogeneity statistics for meta-analyses

**Description**

This function computes a variety of supplemental statistics for meta-analyses. The statistics here are included for interested users. It is strongly recommended that heterogeneity in meta-analysis be interpreted using the $SD_{res}$, $SD_{ρ}$, and $SD_{δ}$ statistics, along with corresponding credibility intervals, which are reported in the default `ma_obj` output (Wiernik et al., 2017).

**Usage**

```r
heterogeneity(
  ma_obj,
  es_failsafe = NULL,
  conf_level = attributes(ma_obj)$inputs$conf_level,
  var_res_ci_method = c("profile_var_es", "profile_Q", "normal_logQ"),
  ...
)
```

**Arguments**

- `ma_obj`: Meta-analysis object.
- `es_failsafe`: Failsafe effect-size value for file-drawer analyses.
- `conf_level`: Confidence level to define the width of confidence intervals (default is `conf_level` specified in `ma_obj`).
- `var_res_ci_method`: Which method to use to estimate the limits. Options are `profile_var_es` for a profile-likelihood interval assuming $\sigma^2_s \chi^2(k - 1)$, `profile_Q` for a profile-likelihood interval assuming $Q \chi^2(k - 1, \lambda)$, $\lambda = \sum_{i=1}^{k} w_i (\theta - \bar{\theta})^2$, and `normal_logQ` for a delta method assuming log(Q) follows a standard normal distribution.
- `...`: Additional arguments.

**Value**

`ma_obj` with heterogeneity statistics added. Included statistics include:

- `es_type`: The effect size metric used.
- `percent_var_accounted`: Percent variance accounted for statistics (by sampling error, by other artifacts, and total). These statistics are widely reported, but not recommended, as they tend to be misinterpreted as suggesting only a small portion of the observed variance is accounted for by sampling error and other artifacts (Schmidt, 2010; Schmidt & Hunter, 2015, p. 15, 425). The square roots of these values are more interpretable and appropriate indices of the relations between observed effect sizes and statistical artifacts (see `cor(es,perturbations)`).
The correlation between observed effect sizes and statistical artifacts in each sample (with sampling error, with other artifacts, and with artifacts in total), computed as $\sqrt{\text{percent var accounted}}$. These indices are more interpretable and appropriate indices of the relations between observed effect sizes and statistical artifacts than percent_var_accounted.

rel_es_obs

$1 - \frac{\text{var}_\text{es}}{\text{var}_\text{pre} + \text{var}_\text{es}}$, the reliability of observed effect size differences as indicators of true effect sizes differences in the sampled studies. This value is useful for correcting correlations between moderators and effect sizes in meta-regression.

H_squared

The ratio of the observed effect size variance to the predicted (error) variance. Also the square root of Q divided by its degrees of freedom.

H

The ratio of the observed effect size standard deviation to the predicted (error) standard deviation.

I_squared

The estimated percent variance not accounted for by sampling error or other artifacts (attributable to moderators and uncorrected artifacts). This statistic is simply rel_es_obs expressed as a percentage rather than a decimal.

Q

Cochran’s $\chi^2$ statistic. Significance tests using this statistic are strongly discouraged; heterogeneity should instead be determined by examining the width of the credibility interval and the practical differences between effect sizes contained within it (Wiernik et al., 2017). This value is not accurate when artifact distribution methods are used for corrections.

tau_squared

$\tau^2$, an estimator of the random effects variance component (analogous to the Hunter-Schmidt $SD^2_{res}$, $SD^2_\rho$, or $SD^2_\delta$ statistics), with its confidence interval. This value is not accurate when artifact distribution methods are used for corrections.

tau

$\sqrt{\tau^2}$, analogous to the Hunter-Schmidt $SD^2_{res}$, $SD^2_\rho$, and $SD^2_\delta$ statistics, with its confidence interval. This value is not accurate when artifact distribution methods are used for corrections.

Q_r, H_r_squared, H_r, I_r_squared, tau_r_squared, tau_r

Outlier-robust versions of these statistics, computed based on absolute deviations from the weighted mean effect size (see Lin et al., 2017). These values are not accurate when artifact distribution methods are used for corrections.

Q_m, H_m_squared, H_m, I_m_squared, tau_m_squared, tau_m

Outlier-robust versions of these statistics, computed based on absolute deviations from the weighted median effect size (see Lin et al., 2017). These values are not accurate when artifact distribution methods are used for corrections.

file_drawer

Fail-safe $N$ and $k$ statistics (file-drawer analyses). These statistics should not be used to evaluate publication bias, as they counterintuitively suggest less when publication bias is strong (Becker, 2005). However, in the absence of publication bias, they can be used as an index of second-order sampling error (how likely is a mean effect to reduce to the specified value with additional studies?). The confidence interval around the mean effect can be used more directly for the same purpose.

Results are reported using computation methods described by Schmidt and Hunter. For barebones and individual-correction meta-analyses, results are also
heterogeneity

reported using computation methods described by DerSimonian and Laird, outlier-robust computation methods, and, if weights from \pkg{metafor} are used, heterogeneity results from \pkg{metafor}.

References


Examples

```r
## Correlations
ma_obj <- ma_r_ic(rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi, ux = ux,
                  correct_rr_y = FALSE, data = data_r_uvirr)
ma_obj <- ma_r_ad(ma_obj, correct_rr_y = FALSE)
ma_obj <- heterogeneity(ma_obj = ma_obj)
ma_obj$heterogeneity[[1]]$barebones
ma_obj$heterogeneity[[1]]$individual_correction$true_score
ma_obj$heterogeneity[[1]]$artifact_distribution$true_score

## d values
ma_obj <- ma_d_ic(d = d, n1 = n1, n2 = n2, ryy = ryyi,
                  data = data_d_meas_multi)
ma_obj <- ma_d_ad(ma_obj)
ma_obj <- heterogeneity(ma_obj = ma_obj)
ma_obj$heterogeneity[[1]]$barebones
ma_obj$heterogeneity[[1]]$individual_correction$latentGroup_latentY
ma_obj$heterogeneity[[1]]$artifact_distribution$latentGroup_latentY
```
confidence limits of tau

Description

Note that this interval does not incorporate uncertainty in artifact estimates, so the interval will be somewhat conservative when applied to individual-correction or artifact-distribution meta-analyses.

Usage

```r
limits_tau(
  var_es,
  var_pre,
  k,
  method = c("profile_var_es", "profile_Q", "normal_logQ"),
  conf_level = 0.95,
  var_unbiased = TRUE
)
```

Arguments

- `var_es`: The observed variance of effect sizes.
- `var_pre`: The predicted variance of effect sizes due to artifacts.
- `k`: The number of studies in a meta-analysis.
- `method`: Which method to use to estimate the limits. Options are `profile_var_es` for a profile-likelihood interval assuming $\sigma^2 z_s \chi^2 (k-1)$, `profile_Q` for a profile-likelihood interval assuming $Q \chi^2 (k-1, \lambda)$, $\lambda = \sum_{i=1}^k w_i (\theta - \bar{\theta})^2$, and `normal_logQ` for a delta method assuming log(Q) follows a standard normal distribution.
- `conf_level`: Confidence level.
- `var_unbiased`: Are variances computed using the unbiased (TRUE) or maximum likelihood (FALSE) estimator?

Value

The confidence limits of tau

Examples

```r
limits_tau(var_es = 0.008372902, var_pre = 0.004778935, k = 20)
```
limits_tau2  
Confidence limits of tau-squared

Description

Note that this interval does not incorporate uncertainty in artifact estimates, so the interval will be somewhat conservative when applied to individual-correction or artifact-distribution meta-analyses.

Usage

limits_tau2(  
var_es,  
var_pre,  
k,  
method = c("profile_var_es", "profile_Q", "normal_logQ"),  
conf_level = 0.95,  
var_unbiased = TRUE  
)

Arguments

- **var_es**: The observed variance of effect sizes.
- **var_pre**: The predicted variance of effect sizes due to artifacts.
- **k**: The number of studies in a meta-analysis.
- **method**: Which method to use to estimate the limits. Options are `profile_var_es` for a profile-likelihood interval assuming $\sigma^2 e \chi^2 (k - 1)$, `profile_Q` for a profile-likelihood interval assuming $Q \chi^2 (k - 1, \lambda)$, $\lambda = \sum_{i=1}^{k} w_i (\theta - \bar{\theta})^2$, and `normal_logQ` for a delta method assuming $\log (Q)$ follows a standard normal distribution.
- **conf_level**: Confidence level.
- **var_unbiased**: Are variances computed using the unbiased (TRUE) or maximum likelihood (FALSE) estimator?

Value

The confidence limits of tau-squared

Examples

```r
limits_tau2(var_es = 0.008372902, var_pre = 0.004778935, k = 20)
```
\textbf{lm_mat}

\begin{quote}
\textit{lm_mat} \hspace{1cm} \textit{Compute linear regression models and generate "lm" objects from covariance matrices.}
\end{quote}

\section*{Description}

Compute linear regression models and generate "lm" objects from covariance matrices.

\section*{Usage}

\begin{verbatim}
\textbf{lm_mat}( \\
    formula, \\
    cov_mat, \\
    mean_vec = rep(0, ncol(cov_mat)), \\
    n = Inf, \\
    se_beta_method = c("lm", "normal"), \\
    \ldots \\
)
\end{verbatim}

\begin{verbatim}
\textbf{matrixreg}( \\
    formula, \\
    cov_mat, \\
    mean_vec = rep(0, ncol(cov_mat)), \\
    n = Inf, \\
    se_beta_method = c("lm", "normal"), \\
    \ldots \\
)
\end{verbatim}

\begin{verbatim}
\textbf{matreg}( \\
    formula, \\
    cov_mat, \\
    mean_vec = rep(0, ncol(cov_mat)), \\
    n = Inf, \\
    se_beta_method = c("lm", "normal"), \\
    \ldots \\
)
\end{verbatim}

\begin{verbatim}
\textbf{lm_matrix}( \\
    formula, \\
    cov_mat, \\
    mean_vec = rep(0, ncol(cov_mat)), \\
    n = Inf, \\
    se_beta_method = c("lm", "normal"), \\
    \ldots \\
)
\end{verbatim}
Arguments

- **formula**: Regression formula with a single outcome variable on the left-hand side and one or more predictor variables on the right-hand side (e.g., \( Y \sim X_1 + X_2 \)).
- **cov_mat**: Covariance matrix containing the variables to be used in the regression.
- **mean_vec**: Vector of means corresponding to the variables in `cov_mat`.
- **n**: Sample size to be used in significance testing.
- **se_beta_method**: Method to use to estimate the standard errors of standardized regression (beta) coefficients. Current options include "lm" (estimate standard errors using conventional regression formulas) and "normal" (use the Jones-Waller normal-theory approach from the `fungible::seBeta()` and `fungible::seBetaCor()` functions).

Value

An object with the class "lm_mat" that can be used with summary, print, predict, and anova methods.

Examples

```r
## Generate data
S <- reshape_vec2mat(cov = c(.3 * 2 * 3,
                         .4 * 2 * 4,
                         .5 * 3 * 4),
                     var = c(2, 3, 4)^2,
                     var_names = c("X", "Y", "Z"))
mean_vec <- setNames(c(1, 2, 3), colnames(S))
dat <- data.frame(MASS::mvrnorm(n = 100, mu = mean_vec,
                                 Sigma = S, empirical = TRUE))

## Compute regression models with lm
lm_out1 <- lm(Y ~ X, data = dat)
lm_out2 <- lm(Y ~ X + Z, data = dat)

## Compute regression models with lm_mat
matreg_out1 <- lm_mat(formula = Y ~ X, cov_mat = S, mean_vec = mean_vec, n = nrow(dat))
matreg_out2 <- lm_mat(formula = Y ~ X + Z, cov_mat = S, mean_vec = mean_vec, n = nrow(dat))

## Compare results of lm and lm_mat with one predictor
lm_out1
datreg_out1

## Compare summaries of lm and lm_mat with one predictor
summary(lm_out1)
summary(matreg_out1)

## Compare results of lm and lm_mat with two predictors
lm_out2
datreg_out2
```
## ma_d

### Meta-analysis of d values

**Description**

The `ma_r_bb`, `ma_r_ic`, and `ma_r_ad` functions implement bare-bones, individual-correction, and artifact-distribution correction methods for $d$ values, respectively. The `ma_d` function is the master function for meta-analyses of $d$ values - it facilitates the computation of bare-bones, artifact-distribution, and individual-correction meta-analyses of correlations for any number of group-wise
contrasts and any number of dependent variables. When artifact-distribution meta-analyses are performed, ma_d will automatically extract the artifact information from a database and organize it into the requested type of artifact distribution object (i.e., either Taylor series or interactive artifact distributions). ma_d is also equipped with the capability to clean databases containing inconsistently recorded artifact data, impute missing artifacts (when individual-correction meta-analyses are requested), and remove dependency among samples by forming composites or averaging effect sizes and artifacts. The automatic compositing features in ma_d are employed when sample_ids and/or construct names are provided.

Usage

```r
ma_d(
  d,
  n1,
  n2 = NULL,
  n_adj = NULL,
  sample_id = NULL,
  citekey = NULL,
  treat_as_r = FALSE,
  ma_method = c("bb", "ic", "ad"),
  ad_type = c("tsa", "int"),
  correction_method = "auto",
  group_id = NULL,
  group1 = NULL,
  group2 = NULL,
  group_order = NULL,
  construct_y = NULL,
  facet_y = NULL,
  measure_y = NULL,
  construct_order = NULL,
  wt_type = c("n_effective", "sample_size", "inv_var_mean", "inv_var_sample", "DL",
             "HE", "HS", "SJ", "ML", "REML", "EB", "PM"),
  correct_bias = TRUE,
  correct_rel = NULL,
  correct_rGg = FALSE,
  correct_ryy = TRUE,
  correct_rr = NULL,
  correct_rr_g = TRUE,
  correct_rr_y = TRUE,
  indirect_rr = NULL,
  indirect_rr_g = TRUE,
  indirect_rr_y = TRUE,
  rGg = NULL,
  pi = NULL,
  pa = NULL,
  ryy = NULL,
  ryy_restricted = TRUE,
  ryy_type = "alpha",
  k_items_y = NULL,
)
ma_d

uy = NULL,
uy_observed = TRUE,
sign_rz = NULL,
sign_rgz = 1,
sign_ryz = 1,
moderators = NULL,
cat_moderators = TRUE,
moderator_type = c("simple", "hierarchical", "none"),
supplemental_ads = NULL,
data = NULL,
control = control_psychmeta(),
...
)

ma_d_ad(
  ma_obj,
  ad_obj_g = NULL,
  ad_obj_y = NULL,
correction_method = "auto",
use_ic_ads = c("tsa", "int"),
correct_rGg = FALSE,
correct_ryy = TRUE,
correct_rr_g = TRUE,
correct_rr_y = TRUE,
indirect_rr_g = TRUE,
indirect_rr_y = TRUE,
sign_rgz = 1,
sign_ryz = 1,
control = control_psychmeta(),
...
)

ma_d_bb(
  d,
  n1,
  n2 = rep(NA, length(d)),
n_adj = NULL,
sample_id = NULL,
citekey = NULL,
wt_type = c("n_effective", "sample_size", "inv_var_mean", "inv_var_sample", "DL",
          "HE", "HS", "SJ", "ML", "REML", "EB", "PM"),
correct_bias = TRUE,
moderators = NULL,
cat_moderators = TRUE,
moderator_type = c("simple", "hierarchical", "none"),
data = NULL,
control = control_psychmeta(),
...
Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>d</code></td>
<td>Vector or column name of observed <code>d</code> values.</td>
</tr>
<tr>
<td><code>n1</code></td>
<td>Vector or column name of sample sizes.</td>
</tr>
<tr>
<td><code>n2</code></td>
<td>Vector or column name of sample sizes.</td>
</tr>
<tr>
<td><code>n_adj</code></td>
<td>Optional: Vector or column name of sample sizes adjusted for sporadic artifact corrections.</td>
</tr>
<tr>
<td><code>sample_id</code></td>
<td>Optional vector of identification labels for samples/studies in the meta-analysis.</td>
</tr>
</tbody>
</table>
citekey | Optional vector of bibliographic citation keys for samples/studies in the meta-analysis (if multiple citekeys pertain to a given effect size, combine them into a single string entry with comma delimiters (e.g., "citekey1,citekey2").

treat_as_r | Logical scalar determining whether $d$ values are to be meta-analyzed as $d$ values (FALSE; default) or whether they should be meta-analyzed as correlations and have the final results converted to the $d$ metric (TRUE).

ma_method | Method to be used to compute the meta-analysis: "bb" (barebones), "ic" (individual correction), or "ad" (artifact distribution).

ad_type | For when ma_method is "ad", specifies the type of artifact distribution to use: "int" or "tsa".

correction_method | Character scalar or a matrix with group_id levels as row names and construct_y levels as column names. When ma_method is "ad", select one of the following methods for correcting artifacts: "auto", "meas", "uvdrr", "uvirr", "bvdr", "bvrr", "rbOrig", "rb1Orig", "rb2Orig", "rbAdj", "rb1Adj", and "rb2Adj". (note: "rb1Orig", "rb2Orig", "rb1Adj", and "rb2Adj" can only be used when Taylor series artifact distributions are provided and "rbOrig" and "rbAdj" can only be used when interactive artifact distributions are provided). See "Details" of ma_d_ad for descriptions of the available methods.

group_id | Vector of group comparison IDs (e.g., Treatment1-Control, Treatment2-Control). The group_id argument supersedes the group1 and group2 arguments. If group_id is not NULL, the values supplied to the group_order argument must correspond to group_id values.

group1, group2 | Vector of group identification labels (e.g., Treatment1, Treatment2, Control)

group_order | Optional vector indicating the order in which (1) group1 and group2 values or (2) group_ids should be arranged. If group_order is NULL, the order of group pairings will be determined internally using alpha-numeric ordering.

construct_y | Vector of construct names for construct designated as "Y".

facet_y | Vector of facet names for constructs designated as "Y". Facet names "global", "overall", and "total" are reserved to indicate observations that represent effect sizes that have already been composited or that represent construct-level measurements rather than facet-level measurements. To avoid double-compositing, any observation with one of these reserved names will only be eligible for auto-compositing with other such observations and will not be combined with narrow facets.

measure_y | Vector of names for measures associated with constructs designated as "Y".

construct_order | Vector indicating the order in which Y variables should be arranged.

wt_type | Type of weight to use in the meta-analysis: options are "n_effective" (effective sample size), "sample_size", "inv_var_mean" (inverse variance computed using mean effect size), and "inv_var_sample" (inverse variance computed using sample-specific effect sizes). Supported options borrowed from metafor are "DL", "HE", "HS", "SJ", "ML", "REML", "EB", and "PM" (see metafor documentation for details about the metafor methods).

correct_bias | Logical scalar that determines whether to correct correlations for small-sample bias (TRUE) or not (FALSE).
correct_rel
Optional named vector that supersedes correct_rGg and correct_ryy. Names should correspond to construct names in group_id and construct_y to determine which constructs should be corrected for unreliability.

correct_rGg
Logical scalar or vector that determines whether to correct the grouping variable variable for measurement error (TRUE) or not (FALSE).

correct_ryy
Logical scalar or vector that determines whether to correct the Y variable for measurement error (TRUE) or not (FALSE).

correct_rr
Optional named vector that supersedes correct_rr_g and correct_rr_y. Names should correspond to construct names in group_id and construct_y to determine which constructs should be corrected for range restriction.

correct_rr_g
Logical scalar or vector or column name determining whether each $d$ value should be corrected for range restriction in the grouping variable (TRUE) or not (FALSE).

correct_rr_y
Logical scalar or vector or column name determining whether each $d$ should be corrected for range restriction in Y (TRUE) or not (FALSE).

indirect_rr
Optional named vector that supersedes indirect_rr_g and indirect_rr_y. Names should correspond to construct names in group_id and construct_y to determine which constructs should be corrected for indirect range restriction.

indirect_rr_g
Logical vector or column name determining whether each $d$ should be corrected for indirect range restriction in the grouping variable (TRUE) or not (FALSE). Superseded in evaluation by correct_rr_g (i.e., if correct_rr_g == FALSE, the value supplied for indirect_rr_g is disregarded).

indirect_rr_y
Logical vector or column name determining whether each $d$ should be corrected for indirect range restriction in Y (TRUE) or not (FALSE). Superseded in evaluation by correct_rr_y (i.e., if correct_rr_y == FALSE, the value supplied for indirect_rr_y is disregarded).

rGg
Vector or column name of reliability estimates for X.

pi
Scalar or vector containing the restricted-group proportions of group membership. If a vector, it must either (1) have as many elements as there are $d$ values or (2) be named so as to match with levels of the group_id argument.

pa
Scalar or vector containing the unrestricted-group proportions of group membership (default = .5). If a vector, it must either (1) have as many elements as there are $d$ values or (2) be named so as to match with levels of the group_id argument.

ryy
Vector or column name of reliability estimates for Y.

ryy_restricted
Logical vector or column name determining whether each element of ryy is an incumbent reliability (TRUE) or an applicant reliability (FALSE).

ryy_type
String vector identifying the types of reliability estimates supplied (e.g., "alpha", "retest", "interrater_r", "splithalf"). See the documentation for ma_r for a full list of acceptable reliability types.

k_items_y
Numeric vector identifying the number of items in each scale.

uy
Vector or column name of u ratios for Y.

uy_observed
Logical vector or column name determining whether each element of uy is an observed-score u ratio (TRUE) or a true-score u ratio (FALSE).
Optional named vector that supersedes `sign_rgz` and `sign_ryz`. Names should correspond to construct names in `group_id` and `construct_y` to determine the sign of each construct's relationship with the selection mechanism.

Sign of the relationship between X and the selection mechanism (for use with `bvrir` corrections only).

Sign of the relationship between Y and the selection mechanism (for use with `bvrir` corrections only).

Matrix or column names of moderator variables to be used in the meta-analysis (can be a vector in the case of one moderator).

Logical scalar or vector identifying whether variables in the `moderators` argument are categorical variables (TRUE) or continuous variables (FALSE).

Type of moderator analysis: "none" means that no moderators are to be used, "simple" means that moderators are to be examined one at a time, "hierarchical" means that all possible combinations and subsets of moderators are to be examined, and "all" means that simple and hierarchical moderator analyses are to be performed.

Named list (named according to the constructs included in the meta-analysis) of supplemental artifact distribution information from studies not included in the meta-analysis. This is a list of lists, where the elements of a list associated with a construct are named like the arguments of the `create_ad()` function.

Data frame containing columns whose names may be provided as arguments to vector arguments and/or moderators.

Output from the `control_psychmeta()` function or a list of arguments controlled by the `control_psychmeta()` function. Ellipsis arguments will be screened for internal inclusion in `control`.

Further arguments to be passed to functions called within the meta-analysis.

For `ma_d_ad` only: Meta-analysis object of correlations or `d` values (regardless of input metric, output metric will be `d`).

For `ma_d_ad` only: Artifact-distribution object for the grouping variable (output of the `create_ad` or `create_ad_group` functions). If `ma_obj` is of the class `ma_master` (i.e., the output of `ma_r` or `ma_d`), the object supplied for `ad_obj_g` must be a named list of artifact distributions with names corresponding to the "X" constructs in the meta-analyses contained within `ma_obj`.

For `ma_d_ad` only: AArtifact-distribution object for the Y variable (output of the `create_ad` function). If `ma_obj` is of the class `ma_master`, the object supplied for `ad_obj_y` must be a named list of artifact distributions with names corresponding to the "Y" constructs in the meta-analyses contained within `ma_obj`.

For `ma_d_ad` only: Determines whether artifact distributions should be extracted from the individual correction results in `ma_obj`. Only evaluated when `ad_obj_g` or `ad_obj_y` is `NULL` and `ma_obj` does not contain individual correction results. Use one of the following commands: `tsa` to use the Taylor series method or `int` to use the interactive method.
supplemental_ads_y
For ma_d_ic only: List supplemental artifact distribution information from studies not included in the meta-analysis. The elements of this list are named like the arguments of the create_ad() function.

Details
The options for correction_method are:

- "auto"
  Automatic selection of the most appropriate correction procedure, based on the available artifacts and the logical arguments provided to the function. (default)
- "meas"
  Correction for measurement error only.
- "uvdrr"
  Correction for univariate direct range restriction (i.e., Case II). The choice of which variable to correct for range restriction is made using the correct_rr_x and correct_rr_y arguments.
- "uvirr"
  Correction for univariate indirect range restriction (i.e., Case IV). The choice of which variable to correct for range restriction is made using the correct_rr_x and correct_rr_y arguments.
- "bvdrr"
  Correction for bivariate direct range restriction. Use with caution: This correction is an approximation only and is known to have a positive bias.
- "bvirr"
  Correction for bivariate indirect range restriction (i.e., Case V).
- "rbOrig"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied interactively. We recommend using "uvdrr" instead.
- "rbAdj"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied interactively. Adjusted to account for range restriction in the reliability of the Y variable. We recommend using "uvdrr" instead.
- "rb1Orig"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied using their TSA1 method. We recommend using "uvdrr" instead.
- "rb1Adj"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied using their TSA1 method. Adjusted to account for range restriction in the reliability of the Y variable. We recommend using "uvdrr" instead.
- "rb2Orig"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied using their TSA2 method. We recommend using "uvdrr" instead.
- "rb2Adj"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied using their TSA2 method. Adjusted to account for range restriction in the reliability of the Y variable. We recommend using "uvdrr" instead.
Value

A nested tabular object of the class "ma_psychmeta". Components of output tables for bare-bones meta-analyses:

- **Pair_ID**
  Unique identification number for each construct-contrast pairing.

- **group_contrast**
  Name of the variable analyzed as the group-contrast variable.

- **construct_y**
  Name of the variable analyzed as construct Y.

- **analysis_id**
  Unique identification number for each analysis.

- **analysis_type**
  Type of moderator analyses: Overall, Simple Moderator, or Hierarchical Moderator.

- **k**
  Number of effect sizes meta-analyzed.

- **N**
  Total sample size of all effect sizes in the meta-analysis.

- **mean_d**
  Mean observed $d$ value.

- **var_d**
  Weighted variance of observed $d$ values.

- **var_e**
  Predicted sampling-error variance of observed $d$ values.

- **var_res**
  Variance of observed $d$ values after removing predicted sampling-error variance.

- **sd_d**
  Square root of var_r.

- **se_d**
  Standard error of mean_d.

- **sd_e**
  Square root of var_e.

- **sd_res**
  Square root of var_res.

- **CI_LL_XX**
  Lower limit of the confidence interval around mean_d, where "XX" represents the confidence level as a percentage.

- **CI_UL_XX**
  Upper limit of the confidence interval around mean_d, where "XX" represents the confidence level as a percentage.

- **CR_LL_XX**
  Lower limit of the credibility interval around mean_d, where "XX" represents the credibility level as a percentage.
• CR_UL_XX
  Upper limit of the credibility interval around mean_d, where "XX" represents the credibility level as a percentage.

Components of output tables for individual-correction meta-analyses:

• pair_id
  Unique identification number for each construct-contrast pairing.

• group_contrast
  Name of the variable analyzed as the group-contrast variable.

• construct_y
  Name of the variable analyzed as construct Y.

• analysis_id
  Unique identification number for each analysis.

• analysis_type
  Type of moderator analyses: Overall, Simple Moderator, or Hierarchical Moderator.

• k
  Number of effect sizes meta-analyzed.

• N
  Total sample size of all effect sizes in the meta-analysis.

• mean_d
  Mean observed d value.

• var_d
  Weighted variance of observed d values.

• var_e
  Predicted sampling-error variance of observed d values.

• var_res
  Variance of observed d values after removing predicted sampling-error variance.

• sd_d
  Square root of var_r.

• se_d
  Standard error of mean_d.

• sd_e
  Square root of var_e.

• sd_res
  Square root of var_res.

• mean_delta
  Mean artifact-corrected d value.

• var_d_c
  Variance of artifact-corrected d values.

• var_e_c
  Predicted sampling-error variance of artifact-corrected d values.

• var_delta
  Variance of artifact-corrected d values after removing predicted sampling-error variance.
Components of output tables for artifact-distribution meta-analyses:

- **pair_id**
  Unique identification number for each construct-contrast pairing.

- **group_contrast**
  Name of the variable analyzed as the group-contrast variable.

- **construct_y**
  Name of the variable analyzed as construct Y.

- **analysis_id**
  Unique identification number for each analysis.

- **analysis_type**
  Type of moderator analyses: Overall, Simple Moderator, or Hierarchical Moderator.

- **k**
  Number of effect sizes meta-analyzed.

- **N**
  Total sample size of all effect sizes in the meta-analysis.

- **mean_d**
  Mean observed $d$ value.

- **var_d**
  Weighted variance of observed $d$ values.

- **var_e**
  Predicted sampling-error variance of observed $d$ values.
• **var_art**  
  Amount of variance in observed $d$ values that is attributable to measurement-error and range-restriction artifacts.

• **var_pre**  
  Total predicted artifactual variance (i.e., the sum of $var_e$ and $var_art$).

• **var_res**  
  Variance of observed $d$ values after removing predicted sampling-error variance and predicted artifact variance.

• **sd_d**  
  Square root of $var_d$.

• **se_d**  
  Standard error of $mean_d$.

• **sd_e**  
  Square root of $var_e$.

• **sd_art**  
  Square root of $var_art$.

• **sd_pre**  
  Square root of $var_pre$.

• **sd_res**  
  Square root of $var_res$.

• **mean_delta**  
  Mean artifact-corrected $d$ value.

• **var_d**  
  Weighted variance of observed $d$ values corrected to the metric of delta.

• **var_e**  
  Predicted sampling-error variance of observed $d$ values corrected to the metric of delta.

• **var_art**  
  Amount of variance in observed $d$ values that is attributable to measurement-error and range-restriction artifacts corrected to the metric of delta.

• **var_pre**  
  Total predicted artifactual variance (i.e., the sum of $var_e$ and $var_art$) corrected to the metric of delta.

• **var_delta**  
  Variance of artifact-corrected $d$ values after removing predicted sampling-error variance and predicted artifact variance.

• **sd_d**  
  Square root of $var_d$ corrected to the metric of delta.

• **se_d**  
  Standard error of $mean_d$ corrected to the metric of delta.

• **sd_e**  
  Square root of $var_e$ corrected to the metric of delta.

• **sd_art**  
  Square root of $var_art$ corrected to the metric of delta.
• sd_pre
  Square root of var_pre corrected to the metric of delta.
• sd_delta
  Square root of var_delta.
• CI_LL_XX
  Lower limit of the confidence interval around mean_delta, where "XX" represents the confidence level as a percentage.
• CI_UL_XX
  Upper limit of the confidence interval around mean_delta, where "XX" represents the confidence level as a percentage.
• CR_LL_XX
  Lower limit of the credibility interval around mean_delta, where "XX" represents the credibility level as a percentage.
• CR_UL_XX
  Upper limit of the credibility interval around mean_delta, where "XX" represents the credibility level as a percentage.

Note

The difference between "rb" methods with the "orig" and "adj" suffixes is that the original does not account for the impact of range restriction on criterion reliabilities, whereas the adjusted procedure attempts to estimate the applicant reliability information for the criterion. The "rb" procedures are included for posterity: We strongly recommend using the "uvdrr" procedure to appropriately correct for univariate range restriction.

References


Dahlke, J. A., & Wiernik, B. M. (2018). One of these artifacts is not like the others: Accounting for indirect range restriction in organizational and psychological research. Manuscript submitted for review.


Examples

```r
## Demonstration of ma_d

# The 'ma_d' function can compute multi-construct bare-bones meta-analyses:
ma_d(d = d, n1 = n1, n2 = n2, construct_y = construct, data = data_d_meas_multi)

# It can also perform multiple individual-correction meta-analyses:
ma_d(ma_method = "ic", d = d, n1 = n1, n2 = n2, ryy = ryy1,
    construct_y = construct, data = data_d_meas_multi)
```
And 'ma_d' can also curate artifact distributions and compute multiple artifact-distribution meta-analyses:

```r
ma_d(ma_method = "ad", d = d, n1 = n1, n2 = n2,
    ryy = ryy, correct_rr_y = FALSE,
    construct_y = construct, data = data_d_meas_multi)
```

### Demonstration of ma_d_bb ###

Example meta-analyses using simulated data:

```r
ma_d_bb(d = d, n1 = n1, n2 = n2,
    data = data_d_meas_multi[data_d_meas_multi$construct == "Y",])
ma_d_bb(d = d, n1 = n1, n2 = n2,
    data = data_d_meas_multi[data_d_meas_multi$construct == "Z",])
```

### Demonstration of ma_d_ic ###

Example meta-analyses using simulated data:

```r
ma_d_ic(d = d, n1 = n1, n2 = n2, ryy = ryy, correct_rr_y = FALSE,
    data = data_d_meas_multi[data_d_meas_multi$construct == "Y",])
ma_d_ic(d = d, n1 = n1, n2 = n2, ryy = ryy, correct_rr_y = FALSE,
    data = data_d_meas_multi[data_d_meas_multi$construct == "Z",])
```

---

**ma_d_order2**

**Second-order meta-analysis function for d values**

**Description**

This function computes second-order meta-analysis function for $d$ values. It supports second-order analyses of bare-bones, artifact-distribution, and individual-correction meta-analyses.

**Usage**

```r
ma_d_order2(
    k,
    N = NULL,
    d = NULL,
    delta = NULL,
    var_d = NULL,
    var_d_c = NULL,
    ma_type = c("bb", "ic", "ad"),
    sample_id = NULL,
    citekey = NULL,
    moderators = NULL,
    moderator_type = "simple",
    construct_x = NULL,
    construct_y = NULL,
    construct_order = NULL,
    data = NULL,
    control = control_psychmeta(),
)```
Arguments

- **k**: Vector or column name of meta-analyses’ k values.
- **N**: Vector or column name of meta-analyses’ total sample sizes (optional).
- **d**: Vector or column name of mean observed $d$ values.
- **delta**: Vector or column name of mean corrected $d$ values.
- **var_d**: Vector or column name of observed variances of observed $d$ values.
- **var_d_c**: Vector or column name of observed variances of corrected $d$ values.
- **ma_type**: Type of meta-analyses being analyzed: "bb" (barebones), "ic" (individual correction), or "ad" (artifact distribution).
- **sample_id**: Vector or column name of study ID labels.
- **citekey**: Optional vector of bibliographic citation keys for samples/studies in the meta-analysis (if multiple citekeys pertain to a given effect size, combine them into a single string entry with comma delimiters (e.g., "citekey1,citekey2").
- **moderators**: Matrix or column names of moderator variables to be used in the meta-analysis (can be a vector in the case of one moderator).
- **moderator_type**: Type of moderator analysis ("none", "simple", or "hierarchical").
- **construct_x**: Vector or column name of construct names for X.
- **construct_y**: Vector or column name of construct names for Y.
- **construct_order**: Vector indicating the order in which variables should be arranged, with variables listed earlier in the vector being preferred for designation as X.
- **data**: Data frame containing columns whose names may be provided as arguments to vector arguments and/or moderators.
- **control**: Output from the control_psychmeta() function or a list of arguments controlled by the control_psychmeta() function. Ellipsis arguments will be screened for internal inclusion in control.
- ... Further arguments to be passed to functions called within the meta-analysis.

Value

A nested tabular object of the class "ma_psychmeta".
Bare-bones meta-analysis of generic effect sizes

Description

This function computes bare-bones meta-analyses of any effect size using user-supplied effect error variances.

Usage

ma_generic(
  es, n, var_e, sample_id = NULL, citekey = NULL, construct_x = NULL, construct_y = NULL, group1 = NULL, group2 = NULL, wt_type = c("sample_size", "inv_var", "DL", "HE", "HS", "SJ", "ML", "REML", "EB", "PM"), moderators = NULL, cat_moderators = TRUE, moderator_type = c("simple", "hierarchical", "none"), data = NULL, control = control_psychmeta(), weights = NULL, ... )

Arguments

- **es**: Vector or column name of observed effect sizes.
- **n**: Vector or column name of sample sizes.
- **var_e**: Vector or column name of error variances.
- **sample_id**: Optional vector of identification labels for samples/studies in the meta-analysis.
- **citekey**: Optional vector of bibliographic citation keys for samples/studies in the meta-analysis (if multiple citekeys pertain to a given effect size, combine them into a single string entry with comma delimiters (e.g., "citekey1,citekey2"). When TRUE, program will use sample-size weights, error variances estimated from the mean effect size, maximum likelihood variances, and normal-distribution confidence and credibility intervals.
- **construct_x** and **construct_y**: Vector of construct names for constructs designated as "X" and as "Y".
group1, group2 Vector of groups' names associated with effect sizes that represent pairwise contrasts.

wt_type Type of weight to use in the meta-analysis: native options are "sample_size" and "inv_var" (inverse error variance). Supported options borrowed from metafor are "DL", "HE", "HS", "SJ", "ML", "REML", "EB", and "PM" (see metafor documentation for details about the metafor methods).

moderators Matrix of moderator variables to be used in the meta-analysis (can be a vector in the case of one moderator).

cat_moderators Logical scalar or vector identifying whether variables in the moderators argument are categorical variables (TRUE) or continuous variables (FALSE).

moderator_type Type of moderator analysis ("none", "simple", or "hierarchical").

data Data frame containing columns whose names may be provided as arguments to vector arguments and/or moderators.

control Output from the control_psychmeta() function or a list of arguments controlled by the control_psychmeta() function. Ellipsis arguments will be screened for internal inclusion in control.

weights Optional vector of weights to be used. When weights is non-NULL, these weights override the argument supplied to wt_type.

... Further arguments to be passed to functions called within the meta-analysis.

Value

A nested tabular object of the class "ma_psychmeta".

Examples

```r
es <- c(.3, .5, .8)
n <- c(100, 200, 150)
var_e <- 1 / n
ma_obj <- ma_generic(es = es, n = n, var_e = var_e)
ma_obj
summary(ma_obj)
```

Description

The ma_r_bb, ma_r_ic, and ma_r_ad functions implement bare-bones, individual-correction, and artifact-distribution correction methods for correlations, respectively. The ma_r function is the master function for meta-analyses of correlations - it facilitates the computation of bare-bones, artifact-distribution, and individual-correction meta-analyses of correlations for any number of construct pairs. When artifact-distribution meta-analyses are performed, ma_r will automatically extract the artifact information from a database and organize it into the requested type of artifact distribution object (i.e., either Taylor series or interactive artifact distributions). ma_r is also equipped with
the capability to clean databases containing inconsistently recorded artifact data, impute missing artifacts (when individual-correction meta-analyses are requested), and remove dependency among samples by forming composites or averaging effect sizes and artifacts. The automatic compositing features in `ma_r` are employed when `sample_ids` and/or construct names are provided.

Usage

```r
ma_r(
  rxyi,
  n,
  n_adj = NULL,
  sample_id = NULL,
  citekey = NULL,
  ma_method = c("bb", "ic", "ad"),
  ad_type = c("tsa", "int"),
  correction_method = "auto",
  construct_x = NULL,
  construct_y = NULL,
  facet_x = NULL,
  facet_y = NULL,
  measure_x = NULL,
  measure_y = NULL,
  construct_order = NULL,
  wt_type = c("sample_size", "inv_var_mean", "inv_var_sample", "DL", "HE", "HS", "SJ",
               "ML", "REML", "EB", "PM"),
  correct_bias = TRUE,
  correct_rel = NULL,
  correct_rxx = TRUE,
  correct_ryy = TRUE,
  correct_rr_x = TRUE,
  correct_rr_y = TRUE,
  indirect_rr = NULL,
  indirect_rr_x = TRUE,
  indirect_rr_y = TRUE,
  rxx = NULL,
  rxx_restricted = TRUE,
  rxx_type = "alpha",
  k_items_x = NULL,
  ryy = NULL,
  ryy_restricted = TRUE,
  ryy_type = "alpha",
  k_items_y = NULL,
  ux = NULL,
  ux_observed = TRUE,
  uy = NULL,
  uy_observed = TRUE,
  sign_rz = NULL,
  sign_rxz = 1,
)```
ma_r

sign_ryz = 1,
moderators = NULL,
cat_moderators = TRUE,
moderator_type = c("simple", "hierarchical", "none"),
supplemental_ads = NULL,
data = NULL,
control = control_psychmeta(),
...
)

ma_r_ad(
  ma_obj,
ad_obj_x = NULL,
ad_obj_y = NULL,
correction_method = "auto",
use_ic_ads = c("tsa", "int"),
correct_rxx = TRUE,
correct_ryy = TRUE,
correct_rr_x = TRUE,
correct_rr_y = TRUE,
indirect_rr_x = TRUE,
indirect_rr_y = TRUE,
sign_rxz = 1,
sign_ryz = 1,
control = control_psychmeta(),
...
)

ma_r_bb(
  r,
n,
n_adj = NULL,
sample_id = NULL,
citekey = NULL,
wtn_type = c("sample_size", "inv_var_mean", "inv_var_sample", "DL", "HE", "HS", "SJ",
             "ML", "REML", "EB", "PM"),
correct_bias = TRUE,
moderators = NULL,
cat_moderators = TRUE,
moderator_type = c("simple", "hierarchical", "none"),
data = NULL,
control = control_psychmeta(),
...
)

ma_r_ic(
  rxyi,
n,

}
n_adj = NULL,
sample_id = NULL,
citekey = NULL,
wt_type = c("sample_size", "inv_var_mean", "inv_var_sample", "DL", "HE", "HS", "SJ",
            "ML", "REML", "EB", "PM"),
correct_bias = TRUE,
correct_rxx = TRUE,
correct_ryy = TRUE,
correct_rr_x = TRUE,
correct_rr_y = TRUE,
indirect_rr_x = TRUE,
indirect_rr_y = TRUE,
rxx = NULL,
rxx_restricted = TRUE,
rxx_type = "alpha",
k_items_x = NULL,
ryy = NULL,
ryy_restricted = TRUE,
ryy_type = "alpha",
k_items_y = NULL,
ux = NULL,
ux_observed = TRUE,
uy = NULL,
uy_observed = TRUE,
sign_rxz = 1,
sign_ryz = 1,
moderators = NULL,
cat_moderators = TRUE,
moderator_type = c("simple", "hierarchical", "none"),
supplemental_ads_x = NULL,
supplemental_ads_y = NULL,
data = NULL,
control = control_psychmeta(),
...)

Arguments

*rxyi, r* Vector or column name of observed correlations. The *r* argument is used with the *ma_r_bb* (i.e., the barebones function) function and the *rxyi* argument is used with *ma_r* and *ma_r_ic* (i.e., the function in which corrections are applied).

*n* Vector or column name of sample sizes.

*n_adj* Optional: Vector or column name of sample sizes adjusted for sporadic artifact corrections.

*sample_id* Optional vector of identification labels for samples/studies in the meta-analysis.

*citekey* Optional vector of bibliographic citation keys for samples/studies in the meta-analysis (if multiple citekeys pertain to a given effect size, combine them into a single string entry with comma delimiters (e.g., "citekey1,citekey2").
**ma_r**

<table>
<thead>
<tr>
<th><strong>ma_method</strong></th>
<th>Method to be used to compute the meta-analysis: &quot;bb&quot; (barebones), &quot;ic&quot; (individual correction), or &quot;ad&quot; (artifact distribution).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ad_type</strong></td>
<td>For when ma_method is &quot;ad&quot;. Specifies the type of artifact distribution to use: &quot;int&quot; or &quot;tsa&quot;.</td>
</tr>
<tr>
<td><strong>correction_method</strong></td>
<td>For when ma_method is &quot;ad&quot;. Character scalar or a square matrix with the collective levels of construct_x and construct_y as row names and column names. Select one of the following methods for correcting artifacts: &quot;auto&quot;, &quot;meas&quot;, &quot;uvdrr&quot;, &quot;uvirr&quot;, &quot;bvdrr&quot;, &quot;bvirr&quot;, &quot;rbOrig&quot;, &quot;rb1Orig&quot;, &quot;rb2Orig&quot;, &quot;rbAdj&quot;, &quot;rb1Adj&quot;, and &quot;rb2Adj&quot;. (note: &quot;rb1Orig&quot;, &quot;rb2Orig&quot;, &quot;rb1Adj&quot;, and &quot;rb2Adj&quot; can only be used when Taylor series artifact distributions are provided and &quot;rbOrig&quot; and &quot;rbAdj&quot; can only be used when iterative artifact distributions are provided). See &quot;Details&quot; of <a href="#">ma_r_ad</a> for descriptions of the available methods.</td>
</tr>
<tr>
<td><strong>construct_x, construct_y</strong></td>
<td>Vector of construct names for constructs initially designated as &quot;X&quot; or as &quot;Y&quot;.</td>
</tr>
<tr>
<td><strong>facet_x, facet_y</strong></td>
<td>Vector of facet names for constructs initially designated as &quot;X&quot; or as &quot;Y&quot;. Facet names &quot;global&quot;, &quot;overall&quot;, and &quot;total&quot; are reserved to indicate observations that represent effect sizes that have already been composited or that represent construct-level measurements rather than facet-level measurements. To avoid double-compositing, any observation with one of these reserved names will only be eligible for auto-compositing with other such observations and will not be combined with narrow facets.</td>
</tr>
<tr>
<td><strong>measure_x, measure_y</strong></td>
<td>Vector of names for measures associated with constructs initially designated as &quot;X&quot; or as &quot;Y&quot;.</td>
</tr>
<tr>
<td><strong>construct_order</strong></td>
<td>Vector indicating the order in which variables should be arranged, with variables listed earlier in the vector being preferred for designation as X.</td>
</tr>
<tr>
<td><strong>wt_type</strong></td>
<td>Type of weight to use in the meta-analysis: options are &quot;sample_size&quot;, &quot;inv_var_mean&quot; (inverse variance computed using mean effect size), and &quot;inv_var_sample&quot; (inverse variance computed using sample-specific effect sizes). Supported options borrowed from metafor are &quot;DL&quot;, &quot;HE&quot;, &quot;HS&quot;, &quot;SJ&quot;, &quot;ML&quot;, &quot;REML&quot;, &quot;EB&quot;, and &quot;PM&quot; (see <a href="#">metafor</a> documentation for details about the metafor methods).</td>
</tr>
<tr>
<td><strong>correct_bias</strong></td>
<td>Logical scalar that determines whether to correct correlations for small-sample bias (TRUE) or not (FALSE).</td>
</tr>
<tr>
<td><strong>correct_rel</strong></td>
<td>Optional named vector that supersedes correct_rxx and correct_ryy. Names should correspond to construct names in construct_x and construct_y to determine which constructs should be corrected for unreliability.</td>
</tr>
<tr>
<td><strong>correct_rxx, correct_ryy</strong></td>
<td>Logical scalar or vector that determines whether to correct the X or Y variable for measurement error (TRUE) or not (FALSE).</td>
</tr>
<tr>
<td><strong>correct_rr</strong></td>
<td>Optional named vector that supersedes correct_rr_x and correct_rr_y. Names should correspond to construct names in construct_x and construct_y to determine which constructs should be corrected for range restriction.</td>
</tr>
</tbody>
</table>
Correct RR

`correct_rr_x` Logical scalar, logical vector, or column name determining whether each correlation in \( r_{xyi} \) should be corrected for range restriction in X (TRUE) or not (FALSE). If using artifact distribution methods, this must be a scalar value.

`correct_rr_y` Logical scalar, logical vector, or column name determining whether each correlation in \( r_{xyi} \) should be corrected for range restriction in Y (TRUE) or not (FALSE). If using artifact distribution methods, this must be a scalar value.

`indirect_rr` Optional named vector that supersedes `indirect_rr_x` and `indirect_rr_y`. Names should correspond to construct names in `construct_x` and `construct_y` to determine which constructs should be corrected for indirect range restriction.

`indirect_rr_x` Logical vector or column name determining whether each correlation in \( r_{xyi} \) should be corrected for indirect range restriction in X (TRUE) or not (FALSE). Superseded in evaluation by `correct_rr_x` (i.e., if `correct_rr_x` == FALSE, the value supplied for `indirect_rr_x` is disregarded).

`indirect_rr_y` Logical vector or column name determining whether each correlation in \( r_{xyi} \) should be corrected for indirect range restriction in Y (TRUE) or not (FALSE). Superseded in evaluation by `correct_rr_y` (i.e., if `correct_rr_y` == FALSE, the value supplied for `indirect_rr_y` is disregarded).

`rxx` Vector or column name of reliability estimates for X.

`rxx_restricted` Logical vector or column name determining whether each element of `rxx` is an incumbent reliability (TRUE) or an applicant reliability (FALSE).

`rxx_type`, `ryy_type` String vector identifying the types of reliability estimates supplied. Acceptable reliability types are:

- `internal_consistency` A generic designation for internal-consistency reliability estimates derived from responses to a single test administration.
- `multiple_administrations` A generic designation for reliability estimates derived from multiple administrations of a test.
- `alpha` Coefficient alpha.
- `lambda` Generic designation for a Guttman’s lambda coefficient.
- `lambda1` Guttman’s lambda 1 coefficient.
- `lambda2` Guttman’s lambda 2 coefficient.
- `lambda3` Guttman’s lambda 3 coefficient.
- `lambda4` Guttman’s lambda 4 coefficient.
- `lambda5` Guttman’s lambda 5 coefficient.
- `lambda6` Guttman’s lambda 6 coefficient.
• omega
  Omega coefficient indicating the proportion variance in a variable accounted for by modeled latent factors.
• icc
  Intraclass correlation coefficient.
• interrater_r
  Inter-rater correlation coefficient.
• interrater_r_sb
  Inter-rater correlation coefficient, stepped up with the Spearman-Brown formula.
• splithalf
  Split-half reliability coefficient.
• splithalf_sb
  Split-half reliability coefficient, corrected toward the full test length with the Spearman-Brown formula.
• retest
  Test-retest reliability coefficient.
• parallel
  Parallel-forms reliability coefficient with tests taken during the same testing session.
• alternate
  Alternate-forms reliability coefficient with tests taken during the same testing session.
• parallel_delayed
  Parallel-forms reliability coefficient with tests taken during separate testing sessions with a time delay in between.
• alternate_delayed
  Alternate-forms reliability coefficient with tests taken during separate testing sessions with a time delay in between.

k_items_x, k_items_y
  Numeric vector identifying the number of items in each scale.
ryy
  Vector or column name of reliability estimates for Y.
ryy_restricted
  Logical vector or column name determining whether each element of coderyy is an incumbent reliability (TRUE) or an applicant reliability (FALSE).
ux
  Vector or column name of u ratios for X.
ux_observed
  Logical vector or column name determining whether each element of ux is an observed-score u ratio (TRUE) or a true-score u ratio (FALSE).
uy
  Vector or column name of u ratios for Y.
uy_observed
  Logical vector or column name determining whether each element of uy is an observed-score u ratio (TRUE) or a true-score u ratio (FALSE).

sign_rz
  Optional named vector that supersedes sign_rxz and sign_ryz. Names should correspond to construct names in construct_x and construct_y to determine the sign of each construct’s relationship with the selection mechanism.

sign_rxz
  Sign of the relationship between X and the selection mechanism (for use with bvirr corrections only).
sign_ryz  Sign of the relationship between Y and the selection mechanism (for use with bvrir corrections only).

moderators  Either (1) a vector of column names in data of moderator variables to be used in the meta-analysis (names can be quoted or unquoted), or (2) a vector, data frame, or matrix containing moderator variables.

cat_moderators  Either (1) A character vector listing the variable names in moderators that are categorical, or (2) a logical scalar or vector identifying whether each variable in moderators is categorical (TRUE) or continuous (FALSE).

moderator_type  Type of moderator analysis: "none" means that no moderators are to be used, "simple" means that moderators are to be examined one at a time, and "hierarchical" means that all possible combinations and subsets of moderators are to be examined.

supplemental_ads  For ma_r only: Named list (named according to the constructs included in the meta-analysis) of supplemental artifact distribution information from studies not included in the meta-analysis. This is a list of lists, where the elements of a list associated with a construct are named like the arguments of the create_ad() function.

data  Data frame containing columns whose names may be provided as arguments to vector arguments and/or moderators.

control  Output from the control_psychmeta() function or a list of arguments controlled by the control_psychmeta() function. Ellipsis arguments will be screened for internal inclusion in control.

...  Further arguments to be passed to functions called within the meta-analysis.

ma_obj  For ma_r_ad only: Meta-analysis object of correlations or d values (regardless of input metric, output metric will be r).

ad_obj_x  For ma_r_ad only: Artifact-distribution object for the X variable (output of the create_ad function). If ma_obj is of the class ma_master (i.e., the output of ma_r or ma_d), the object supplied for ad_obj_x must be a named list of artifact distributions with names corresponding to the "X" constructs in the meta-analyses contained within ma_obj.

ad_obj_y  For ma_r_ad only: Artifact-distribution object for the Y variable (output of the create_ad function). If ma_obj is of the class ma_master, the object supplied for ad_obj_y must be a named list of artifact distributions with names corresponding to the "Y" constructs in the meta-analyses contained within ma_obj.

use_ic_ads  For ma_r_ad only: Determines whether artifact distributions should be extracted from the individual correction results in ma_obj. Only evaluated when ad_obj_x or ad_obj_y is NULL and ma_obj does not contain individual correction results. Use one of the following commands: tsa to use the Taylor series method or int to use the interactive method.

supplemental_ads_x, supplemental_ads_y  For ma_r_ic only: List supplemental artifact distribution information from studies not included in the meta-analysis. The elements of this list are named like the arguments of the create_ad() function.
Details

The options for `correction_method` are:

- "auto"
  Automatic selection of the most appropriate correction procedure, based on the available artifacts and the logical arguments provided to the function. (default)

- "meas"
  Correction for measurement error only.

- "uvdrr"
  Correction for univariate direct range restriction (i.e., Case II). The choice of which variable to correct for range restriction is made using the `correct_rr_x` and `correct_rr_y` arguments.

- "uvirr"
  Correction for univariate indirect range restriction (i.e., Case IV). The choice of which variable to correct for range restriction is made using the `correct_rr_x` and `correct_rr_y` arguments.

- "bvdrr"
  Correction for bivariate direct range restriction. Use with caution: This correction is an approximation only and is known to have a positive bias.

- "bvirr"
  Correction for bivariate indirect range restriction (i.e., Case V).

- "rbOrig"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied interactively. We recommend using "uvdrr" instead.

- "rbAdj"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied interactively. Adjusted to account for range restriction in the reliability of the Y variable. We recommend using "uvdrr" instead.

- "rb1Orig"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied using their TSA1 method. We recommend using "uvdrr" instead.

- "rb1Adj"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied using their TSA1 method. Adjusted to account for range restriction in the reliability of the Y variable. We recommend using "uvdrr" instead.

- "rb2Orig"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied using their TSA2 method. We recommend using "uvdrr" instead.

- "rb2Adj"
  Not recommended: Raju and Burke’s version of the correction for direct range restriction, applied using their TSA2 method. Adjusted to account for range restriction in the reliability of the Y variable. We recommend using "uvdrr" instead.

Value

A nested tabular object of the class "ma_psychmeta". Components of output tables for bare-bones meta-analyses:
• **pair_id**
  Unique identification number for each construct pairing.

• **construct_x**
  Name of the variable analyzed as construct X.

• **construct_y**
  Name of the variable analyzed as construct Y.

• **analysis_id**
  Unique identification number for each analysis.

• **analysis_type**
  Type of moderator analyses: Overall, Simple Moderator, or Hierarchical Moderator.

• **k**
  Number of effect sizes meta-analyzed.

• **N**
  Total sample size of all effect sizes in the meta-analysis.

• **mean_r**
  Mean observed correlation.

• **var_r**
  Weighted variance of observed correlations.

• **var_e**
  Predicted sampling-error variance of observed correlations.

• **var_res**
  Variance of observed correlations after removing predicted sampling-error variance.

• **sd_r**
  Square root of var_r.

• **se_r**
  Standard error of mean_r.

• **sd_e**
  Square root of var_e.

• **sd_res**
  Square root of var_res.

• **CI_LL_XX**
  Lower limit of the confidence interval around mean_r, where "XX" represents the confidence level as a percentage.

• **CI_UL_XX**
  Upper limit of the confidence interval around mean_r, where "XX" represents the confidence level as a percentage.

• **CR_LL_XX**
  Lower limit of the credibility interval around mean_r, where "XX" represents the credibility level as a percentage.

• **CR_UL_XX**
  Upper limit of the credibility interval around mean_r, where "XX" represents the credibility level as a percentage.

Components of output tables for individual-correction meta-analyses:
- **pair_id**
  Unique identification number for each construct pairing.

- **construct_x**
  Name of the variable analyzed as construct X.

- **construct_y**
  Name of the variable analyzed as construct Y.

- **analysis_id**
  Unique identification number for each analysis.

- **analysis_type**
  Type of moderator analyses: Overall, Simple Moderator, or Hierarchical Moderator.

- **k**
  Number of effect sizes meta-analyzed.

- **N**
  Total sample size of all effect sizes in the meta-analysis.

- **mean_r**
  Mean observed correlation.

- **var_r**
  Weighted variance of observed correlations.

- **var_e**
  Predicted sampling-error variance of observed correlations.

- **var_res**
  Variance of observed correlations after removing predicted sampling-error variance.

- **sd_r**
  Square root of var_r.

- **se_r**
  Standard error of mean_r.

- **sd_e**
  Square root of var_e.

- **sd_res**
  Square root of var_res.

- **mean_rho**
  Mean artifact-corrected correlation.

- **var_r_c**
  Variance of artifact-corrected correlations.

- **var_e_c**
  Predicted sampling-error variance of artifact-corrected correlations.

- **var_rho**
  Variance of artifact-corrected correlations after removing predicted sampling-error variance.

- **sd_r_c**
  Square root of var_r_c.

- **se_r_c**
  Standard error of mean_rho.
• $sd_e_c$
  Square root of $var_e_c$.

• $sd_{\rho}$
  Square root of $var_{\rho}$.

• $CI_{LL_{XX}}$
  Lower limit of the confidence interval around mean_{\rho}, where "XX" represents the confidence level as a percentage.

• $CI_{UL_{XX}}$
  Upper limit of the confidence interval around mean_{\rho}, where "XX" represents the confidence level as a percentage.

• $CR_{LL_{XX}}$
  Lower limit of the credibility interval around mean_{\rho}, where "XX" represents the credibility level as a percentage.

• $CR_{UL_{XX}}$
  Upper limit of the credibility interval around mean_{\rho}, where "XX" represents the credibility level as a percentage.

Components of output tables for artifact-distribution meta-analyses:

• $pair_id$
  Unique identification number for each construct pairing.

• $construct_x$
  Name of the variable analyzed as construct X.

• $construct_y$
  Name of the variable analyzed as construct Y.

• $analysis_id$
  Unique identification number for each analysis.

• $analysis_type$
  Type of moderator analyses: Overall, Simple Moderator, or Hierarchical Moderator.

• $k$
  Number of effect sizes meta-analyzed.

• $N$
  Total sample size of all effect sizes in the meta-analysis.

• $mean_r$
  Mean observed correlation.

• $var_r$
  Weighted variance of observed correlations.

• $var_e$
  Predicted sampling-error variance of observed correlations.

• $var_art$
  Amount of variance in observed correlations that is attributable to measurement-error and range-restriction artifacts.

• $var_pre$
  Total predicted artifactual variance (i.e., the sum of $var_e$ and $var_art$).
• var_res
  Variance of observed correlations after removing predicted sampling-error variance and predicted artifact variance.

• sd_r
  Square root of var_r.

• se_r
  Standard error of mean_r.

• sd_e
  Square root of var_e.

• sd_art
  Square root of var_art.

• sd_pre
  Square root of var_pre.

• sd_res
  Square root of var_res.

• mean_rho
  Mean artifact-corrected correlation.

• var_r_c
  Weighted variance of observed correlations corrected to the metric of rho.

• var_e_c
  Predicted sampling-error variance of observed correlations corrected to the metric of rho.

• var_art_c
  Amount of variance in observed correlations that is attributable to measurement-error and range-restriction artifacts corrected to the metric of rho.

• var_pre_c
  Total predicted artifactual variance (i.e., the sum of var_e and var_art) corrected to the metric of rho.

• var_rho
  Variance of artifact-corrected correlations after removing predicted sampling-error variance and predicted artifact variance.

• sd_r_c
  Square root of var_r corrected to the metric of rho.

• se_r_c
  Standard error of mean_r corrected to the metric of rho.

• sd_e_c
  Square root of var_e corrected to the metric of rho.

• sd_art_c
  Square root of var_art corrected to the metric of rho.

• sd_pre_c
  Square root of var_pre corrected to the metric of rho.

• sd_rho
  Square root of var_rho.
**CI_LL_XX**
Lower limit of the confidence interval around mean_rho, where "XX" represents the confidence level as a percentage.

**CI_UL_XX**
Upper limit of the confidence interval around mean_rho, where "XX" represents the confidence level as a percentage.

**CR_LL_XX**
Lower limit of the credibility interval around mean_rho, where "XX" represents the credibility level as a percentage.

**CR_UL_XX**
Upper limit of the credibility interval around mean_rho, where "XX" represents the credibility level as a percentage.

**Note**

The difference between "rb" methods with the 'orig' and 'adj' suffixes is that the original does not account for the impact of range restriction on criterion reliabilities, whereas the adjusted procedure attempts to estimate the applicant reliability information for the criterion. The "rb" procedures are included for posterity: We strongly recommend using the "uvdrr" procedure to appropriately correct for univariate range restriction.

**References**


Dahlke, J. A., & Wiernik, B. M. (2018). *One of these artifacts is not like the others: Accounting for indirect range restriction in organizational and psychological research*. Manuscript submitted for review.


**Examples**

```r
## Not run:
## The 'ma_r' function can compute multi-construct bare-bones meta-analyses:
ma_obj <- ma_r(rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi,
                construct_x = x_name, construct_y = y_name, sample_id = sample_id,
                moderators = moderator, data = data_r_meas_multi)
summary(ma_obj)

## It can also perform multiple individual-correction meta-analyses:
ma_obj <- ma_r(ma_method = "ic", rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi,
                construct_x = x_name, construct_y = y_name, sample_id = sample_id,
                moderators = moderator, data = data_r_meas_multi)
```
summary(ma_obj)
ma_obj$meta_tables[[1]]$individual_correction$true_score

## And 'ma_r' can also curate artifact distributions and compute multiple artifact-distribution meta-analyses:
ma_obj <- ma_r(ma_method = "ad", rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi, correct_rr_x = FALSE, correct_rr_y = FALSE, construct_x = x_name, construct_y = y_name, sample_id = sample_id, clean_artifacts = FALSE, impute_artifacts = FALSE, moderators = moderator, data = data_r_meas_multi)
summary(ma_obj)
ma_obj$meta_tables[[1]]$artifact_distribution$true_score

## Even if no studies in the database provide artifact information, pre-specified artifact distributions from previous meta-analyses can still be used! (These results should match the previous example.)
ma_obj <- ma_r(ma_method = "ad", rxyi = rxyi, n = n, correct_rr_x = FALSE, correct_rr_y = FALSE, construct_x = x_name, construct_y = y_name, sample_id = sample_id, clean_artifacts = FALSE, impute_artifacts = FALSE, moderators = moderator, data = data_r_meas_multi, supplemental_ads = list(X = list(mean_qxi = 0.8927818, var_qxi = 0.0008095520, k_qxi = 40, mean_n_qxi = 11927 / 40, qxi_dist_type = "alpha"), Y = list(mean_qxi = 0.8941266, var_qxi = 0.0009367234, k_qxi = 40, mean_n_qxi = 11927 / 40, qxi_dist_type = "alpha"), Z = list(mean_qxi = 0.8962108, var_qxi = 0.0007840593, k_qxi = 40, mean_n_qxi = 11927 / 40, qxi_dist_type = "alpha")))
summary(ma_obj)
ma_obj$meta_tables[[1]]$artifact_distribution$true_score

## Artifact information may also be supplied by passing "ad_obj" class objects with the "supplemental_ads" argument.
## Create a list of artifact-distribution objects:
ad_list <- create_ad_list(n = n, rxx = rxxi, ryy = ryyi, construct_x = x_name, construct_y = y_name, sample_id = sample_id, data = data_r_meas_multi)
ad_list <- setNames(ad_list$ad_x, ad_list$construct_x)
## Run the artifact-distribution meta-analysis:
ma_obj <- ma_r(ma_method = "ad", rxyi = rxyi, n = n, correct_rr_x = FALSE, correct_rr_y = FALSE, construct_x = x_name, construct_y = y_name, sample_id = sample_id, clean_artifacts = FALSE, impute_artifacts = FALSE, moderators = moderator, data = data_r_meas_multi, supplemental_ads = ad_list)
summary(ma_obj)
ma_obj$meta_tables[[1]]$artifact_distribution$true_score

## Artifact information from studies not included in the meta-analysis can also be used to make corrections. Passing artifact information with the 'supplemental_ads' argument allows for
ma_r

## additional artifact values and/or means and variances of artifacts to be used.
## The 'supplemental_ads' analysis below gives the same results as the prior meta-analysis.
x_ids <- c(data_r_meas_multi$x_name, data_r_meas_multi$y_name) == "X"
rxxi <- c(data_r_meas_multi$rxxi, data_r_meas_multi$ryyi)[x_ids]
n_rxxi = c(data_r_meas_multi$n, data_r_meas_multi$n)[x_ids]

y_ids <- c(data_r_meas_multi$x_name, data_r_meas_multi$y_name) == "Y"
ryyi <- c(data_r_meas_multi$rxxi, data_r_meas_multi$ryyi)[y_ids]
n_ryyi = c(data_r_meas_multi$n, data_r_meas_multi$n)[y_ids]

z_ids <- c(data_r_meas_multi$x_name, data_r_meas_multi$y_name) == "Z"
rzzi <- c(data_r_meas_multi$rxxi, data_r_meas_multi$ryyi)[z_ids]
n_rzzi = c(data_r_meas_multi$n, data_r_meas_multi$n)[z_ids]

ma_obj <- ma_r(ma_method = "ad", rxyi = rxxi, n = n,
correct_rr_x = FALSE, correct_rr_y = FALSE,
construct_x = x_name, construct_y = y_name,
moderators = moderator, sample_id = sample_id, data = data_r_meas_multi,
supplemental_ads = list(X = list(rxxi = rxxi, n_rxxi = n_rxxi, wt_rxxi = n_rxxi),
                      Y = list(rxxi = ryyi, n_rxxi = n_ryyi, wt_rxxi = n_ryyi),
                      Z = list(rxxi = rzzi, n_rxxi = n_rzzi, wt_rxxi = n_rzzi)))

summary(ma_obj)

## If 'use_all_arts' is set to TRUE, artifacts from studies without valid correlations
## will be used to inform artifact distributions. Below, correlations and artifacts
## are provided by non-overlapping sets of studies.
dat1 <- dat2 <- data_r_meas_multi
dat1$rxxi <- dat1$ryyi <- NA
dat2$rxyi <- NA
dat2$Sample_id <- dat2$Sample_id + 40
dat <- rbind(dat1, dat2)

ma_obj <- ma_r(ma_method = "ad", rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi,
correct_rr_x = FALSE, correct_rr_y = FALSE,
construct_x = x_name, construct_y = y_name,
moderators = moderator, sample_id = sample_id, data = data_r_meas_multi,
supplemental_ads = TRUE, data = dat)

summary(ma_obj)

### Demonstration of ma_r_bb ###
## Example analysis using data from Gonzalez-Mule et al. (2014):

## Not correcting for bias and using normal distributions to compute uncertainty intervals
## allows for exact replication of the results reported in the text:
ma_r_bb(r = rxyi, n = n, correct_bias = FALSE, conf_method = "norm", cred_method = "norm",
data = data_r_gonzalezmule_2014)

## Using hs_override = TRUE allows one to easily implement the traditional Hunter-Schmidt method:
ma_r_bb(r = rxyi, n = n, hs_override = TRUE, data = data_r_gonzalezmule_2014)
## With hs_override = FALSE, the program defaults will compute unbiased variances and use
## t-distributions to estimate confidence and credibility intervals - these settings make
## a noticeable difference for small studies like the textbook example:
ma_r_bb(r = rxyi, n = n, hs_override = FALSE, data = data_r_gonzalezmule_2014)

### Demonstration of ma_r_ic ###
## Simulated example satisfying the assumptions of the Case IV
## range-restriction correction (parameter values: mean_rho = .3, sd_rho = .15):
ma_r_ic(rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi, ux = ux, data = data_r_uvirr)

## Simulated example satisfying the assumptions of the Case V
## range-restriction correction
ma_r_ic(rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi,
        rxx_type = "parallel", ryy_type = "parallel",
        ux = ux, uy = uy, data = data_r_bvirr)

## Published example from Gonzalez-Mule et al. (2014)
ma_r_ic(rxyi = rxyi, n = n, hs_override = TRUE, data = data_r_gonzalezmule_2014,
        rxx = rxxi, ryy = ryyi, ux = ux, indirect_rr_x = TRUE,
        moderators = c("Rating source", "Published", "Type", "Complexity"))

### Demonstration of ma_r_ad ###
## Compute barebones meta-analysis
ma_obj <- ma_r_bb(r = rxyi, n = n, correct_bias = FALSE,
                   conf_method = "norm", cred_method = "norm", data = data_r_mcdaniel_1994)

## Construct artifact distribution for X
ad_obj_x <- create_ad(ad_type = "tsa", mean_rxxi = data_r_mcdaniel_1994$Mrxi[1],
                      var_rxxi = data_r_mcdaniel_1994$SDrxi[1]^.5,
                      ux = data_r_mcdaniel_1994$ux,
                      wt_ux = data_r_mcdaniel_1994$'ux frequency')

## Construct artifact distribution for Y
ad_obj_y <- create_ad(ad_type = "tsa", rxxi = data_r_mcdaniel_1994$ryyi,
                      wt_rxxi = data_r_mcdaniel_1994$'ryyi frequency')

## Compute artifact-distribution meta-analysis, correcting for measurement error only
ma_r_ad(ma_obj = ma_obj, ad_obj_x = ad_obj_x, ad_obj_y = ad_obj_y, correction_method = "meas")

## Compute artifact-distribution meta-analysis, correcting for univariate direct range restriction
ma_r_ad(ma_obj = ma_obj, ad_obj_x = ad_obj_x, ad_obj_y = ad_obj_y, correction_method = "uvdrr",
        correct_rr_y = FALSE, indirect_rr_x = FALSE)

# The results of ma_r() can also be corrected using artifact distributions
ma_obj <- ma_r(ma_method = "bb", rxyi = rxyi, n = n,
               construct_x = x_name, construct_y = y_name, sample_id = sample_id,
               moderators = moderator, data = data_r_meas_multi)
The `create_ad_list` function can be used to generate batches of artifact-distribution objects. Here is an example in which one distribution is created per construct:

```r
ad_tibble <- create_ad_list(n = n, rxx = rxxi, ryy = ryyi,
                           construct_x = x_name, construct_y = y_name,
                           sample_id = sample_id,
                           data = data_r_meas_multi)
```

Passing that collection of distributions to `ma_r_ad()` corrects 'ma_obj' for artifacts:

```r
ma_obj_tibble <- ma_r_ad(ma_obj = ma_obj,
                         ad_obj_x = ad_tibble, ad_obj_y = ad_tibble)
```

Summary:

```r
summary(ma_obj_tibble)
```

# The same outcomes as the previous example can be achieved by passing a named list of
# artifact information, with each element bearing the name of a construct:

```r
ad_list <- setNames(ad_tibble$ad_x, ad_tibble$construct_x)
ma_obj_list <- ma_r_ad(ma_obj = ma_obj,
                       ad_obj_x = ad_list, ad_obj_y = ad_list)
```

Summary:

```r
summary(ma_obj_list)
```

# It is also possible to construct artifact distributions in a pairwise fashion.
# For example, if correlations between X and Y and between X and Z are being analyzed,
# X will get a different distribution for its relationships with Y than with Z.
# These pairwise distributions are based only on artifact data from specific construct pairs.

```r
ad_tibble_pair <- create_ad_list(n = n, rxx = rxxi, ryy = ryyi,
                                 construct_x = x_name, construct_y = y_name,
                                 sample_id = sample_id,
                                 control = control_psychmeta(pairwise_ads = TRUE),
                                 data = data_r_meas_multi)
```

Passing these pairwise distributions to `ma_r_ad()` corrects 'ma_obj' for artifacts:

```r
ma_obj_pair <- ma_r_ad(ma_obj = ma_obj,
                       ad_obj_x = ad_tibble_pair, ad_obj_y = ad_tibble_pair)
```

Summary:

```r
summary(ma_obj_pair)
```

# Sometimes moderators have important influences on artifact distributions as well as
# distributions of effect sizes. When this occurs, moderated artifact distributions
# can be created to make more appropriate corrections.

```r
ad_tibble_mod <- create_ad_list(n = n, rxx = rxxi, ryy = ryyi,
                                construct_x = x_name, construct_y = y_name,
                                sample_id = sample_id,
                                control = control_psychmeta(moderated_ads = TRUE),
                                moderators = moderator,
                                data = data_r_meas_multi)
```

Passing these moderated distributions to `ma_r_ad()` corrects 'ma_obj' for artifacts:

```r
ma_obj_mod <- ma_r_ad(ma_obj = ma_obj,
                       ad_obj_x = ad_tibble_mod, ad_obj_y = ad_tibble_mod)
```

Summary:

```r
summary(ma_obj_mod)
```

# Sometimes moderators have important influences on artifact distributions as well as
# distributions of effect sizes. When this occurs, moderated artifact distributions
# can be created to make more appropriate corrections.

```r
ad_tibble_mod <- create_ad_list(n = n, rxx = rxxi, ryy = ryyi,
                                construct_x = x_name, construct_y = y_name,
                                sample_id = sample_id,
                                control = control_psychmeta(moderated_ads = TRUE),
                                moderators = moderator,
                                data = data_r_meas_multi)
```

Passing these moderated distributions to `ma_r_ad()` corrects 'ma_obj' for artifacts:

```r
ma_obj_mod <- ma_r_ad(ma_obj = ma_obj,
                       ad_obj_x = ad_tibble_mod, ad_obj_y = ad_tibble_mod)
```

Summary:

```r
summary(ma_obj_mod)
```
# It is also possible to create pairwise moderated artifact distributions.
ad_tibble_pairmod <- create_ad_list(n = n, rxx = rxxi, ryy = ryyi,
construct_x = x_name, construct_y = y_name,
sample_id = sample_id,
control = control_psychmeta(moderated_ads = TRUE,
    pairwise_ads = TRUE),
moderators = moderator,
data = data_r_meas_multi)

# Passing these pairwise moderated distributions to ma_r_ad() corrects 'ma_obj' for artifacts:
ma_obj_pairmod <- ma_r_ad(ma_obj = ma_obj,
ad_obj_x = ad_tibble_pairmod, ad_obj_y = ad_tibble_pairmod)
summary(ma_obj_pairmod)
ma_obj_pairmod$meta_tables[[1]]$artifact_distribution$true_score

# For even more control over which artifact distributions are used in corrections, you can supply
# un-named list of distributions in which the order of distributions corresponds to the order of
# meta-analyses in ma_obj. It is important for the elements to be un-named, as the absence of names
# and the length of the list are the two ways in which ma_r_ad() validates the lists.
ad_list_pairmod_x <- ad_tibble_pairmod$ad_x
ad_list_pairmod_y <- ad_tibble_pairmod$ad_y

# Passing these lists of distributions to ma_r_ad() corrects 'ma_obj' for artifacts:
ma_obj_pairmodlist <- ma_r_ad(ma_obj = ma_obj,
ad_obj_x = ad_list_pairmod_x, ad_obj_y = ad_list_pairmod_y)
summary(ma_obj_pairmodlist)
ma_obj_pairmodlist$meta_tables[[1]]$artifact_distribution$true_score

## End(Not run)

---

### ma_r_order2

#### Second-order meta-analysis function for correlations

**Description**

This function computes second-order meta-analysis function for correlations. It supports second-order analyses of bare-bones, artifact-distribution, and individual-correction meta-analyses.

**Usage**

```r
ma_r_order2(
  k,
  N = NULL,
  r = NULL,
  rho = NULL,
  var_r = NULL,
  var_r_c = NULL,
  ma_type = c("bb", "ie", "ad"),
  sample_id = NULL,
```

```r
data = data_r_meas_multi
```


```r
```
citekey = NULL,
moderators = NULL,
moderator_type = "simple",
construct_x = NULL,
construct_y = NULL,
construct_order = NULL,
data = NULL,
control = control_psychmeta(),
...
)

Arguments

k  Vector or column name of meta-analyses' k values.
N  Vector or column name of meta-analyses' total sample sizes (optional).
r  Vector or column name of mean observed correlations.
rho Vector or column name of mean corrected correlations.
var_r  Vector or column name of observed variances of observed correlations.
var_r_c Vector or column name of observed variances of corrected correlations.
ma_type Type of meta-analyses being analyzed: "bb" (barebones), "ic" (individual correction), or "ad" (artifact distribution).
sample_id Vector or column name of study ID labels.
citekey Optional vector of bibliographic citation keys for samples/studies in the meta-analysis (if multiple citekeys pertain to a given effect size, combine them into a single string entry with comma delimiters (e.g., "citekey1,citekey2")).
moderators Matrix or column names of moderator variables to be used in the meta-analysis (can be a vector in the case of one moderator).
moderator_type Type of moderator analysis ("none", "simple", or "hierarchical").
construct_x Vector or column name of construct names for X.
construct_y Vector or column name of construct names for Y.
construct_order Vector indicating the order in which variables should be arranged, with variables listed earlier in the vector being preferred for designation as X.
data Data frame containing columns whose names may be provided as arguments to vector arguments and/or moderators.
control Output from the control_psychmeta() function or a list of arguments controlled by the control_psychmeta() function. Ellipsis arguments will be screened for internal inclusion in control.
...
Further arguments to be passed to functions called within the meta-analysis.

Value

A nested tabular object of the class "ma_psychmeta".
## Analysis of the validity of conscientiousness as a predictor of job performance in East Asia

```r
out <- ma_r_order2(k = k, r = r_bar_i, rho = rho_bar_i, var_r = var_r,
                   var_r_c = NULL, ma_type = c("bb", "ad"),
                   sample_id = NULL, moderators = NULL,
                   construct_x = NULL, construct_y = NULL,
                   data = dplyr::filter(data_r_oh_2009, Predictor == "Conscientiousness")
summary(out)
```

## Analysis of the validity of the Big Five traits as predictors of job performance in East Asia

```r
out <- ma_r_order2(k = k, r = r_bar_i, rho = rho_bar_i, var_r = var_r,
                   var_r_c = NULL, ma_type = c("bb", "ad"),
                   sample_id = NULL, moderators = NULL, construct_x = Predictor,
                   data = data_r_oh_2009)
summary(out)
```

## Analysis of the average validity of the Big Five traits as predictors of job performance by Eastern Asian country

```r
out <- ma_r_order2(k = k, r = r_bar_i, rho = rho_bar_i, var_r = var_r,
                   var_r_c = NULL, ma_type = c("bb", "ad"),
                   sample_id = NULL, moderators = "Country", data = data_r_oh_2009)
summary(out)
```

### merge_simdat_d

#### Merge multiple "simdat_d_database" class objects

**Description**

This function allows for multiple simulated databases from `simulate_d_database` to be merged together into a single database. Merged databases will be assigned moderator variable codes.

**Usage**

```r
merge_simdat_d(...)  
```

#### Arguments

```r
...  
```

Collection of objects created by the "simulate_d_database" function. Simply enter the database objects as `merge_simdat_d(data_obj1, data_obj2, data_obj_3)`.

#### Value

A merged database of class `simdat_d`
merge_simdat_r  

Merge multiple "simdat_r_database" class objects

Description

This function allows for multiple simulated databases from simulate_r_database to be merged together into a single database. Merged databases will be assigned moderator variable codes.

Usage

merge_simdat_r(...)

Arguments

... Collection of objects created by the "simulate_r_database" function. Simply enter the database objects as merge_simdat_r(data_obj1, data_obj2, data_obj_3).

Value

A merged database of class simdat_r_database

metabulate  

Write a summary table of meta-analytic results

Description

Write a summary table of meta-analytic results

Usage

metabulate(
  ma_obj,
  file = NULL,
  output_dir = getwd(),
  output_format = c("word", "html", "pdf", "odt", "text", "rmd"),
  show_msd = TRUE,
  show_conf = TRUE,
  show_cred = TRUE,
  show_se = FALSE,
  show_var = FALSE,
  analyses = "all",
  match = c("all", "any"),
  case_sensitive = TRUE,
  ma_method = "ad",
  correction_type = "ts",
  collapse_construct_labels = TRUE,
bold_headers = TRUE,
digits = 2L,
decimal.mark = getOption("OutDec"),
leading0 = "conditional",
drop0integer = FALSE,
neg.sign = ";-;",
pos.sign = "figure_html",
big.mark = ";8239;",
big.interval = 3L,
small.mark = ";8239;",
small.interval = 3L,
na.mark = ";-;",
lgl.mark = c("+", ";-;"),
inf.mark = c("+\infty;", ";-\infty;"),
conf_format = "brackets",
cred_format = "brackets",
symbol_es = "ES",
caption = "Results of meta-analyses",
header = NULL,
verbose = FALSE,
unicode = NULL,
bib = NULL,
title.bib = NULL,
style = "apa",
additional_citekeys = NULL,
save_build_files = FALSE,
... 
)

Arguments

ma_obj A psychmeta meta-analysis object.
file The filename (optionally with a subfolder path) for the output file. If NULL, the
function will output directly to the R console (also useful if you want to include
psychmeta results in a larger RMarkdown document).
output_dir The filepath for the output directory/folder. Defaults to the current working
directory.
output_format The format of the output tables. Available options are Word (default), HTML,
PDF (requires LaTeX and the unicode-math LaTeX package to be installed),
ODT, rmd (Rmarkdown), and text (plain text). You can also specify the full
name of another RMarkdown output_format.
show_msd Logical. Should means and standard deviations of effect sizes be shown (default
TRUE)
show_conf Logical. Should confidence intervals be shown (default: TRUE)?
show_cred Logical. Should credibility intervals be shown (default: TRUE)?
show_se Logical Should standard errors be shown (default: FALSE)?
show_var Logical. Should variances be shown (default: FALSE)?

analyses Which analyses to extract references for? See `filter_ma` for details.

match Match all or any of the filter criteria? See `filter_ma` for details.

case_sensitive Logical scalar that determines whether character values supplied in analyses should be treated as case sensitive (TRUE, default) or not (FALSE).

ma_method Meta-analytic methods to be included. Valid options are: "ad", "ic", and "bb". Multiple methods are permitted. By default, results are given for one method with order of priority: 1. "ad", 2. "ic", 3. "bb".

correction_type Type of meta-analytic corrections to be included. Valid options are: "ts" (default), "vgx", and "vgy". Multiple options are permitted.

collapse_construct_labels Should the construct labels for construct pairs with multiple rows of results be simplified so that only the first occurrence of each set of construct names is shown (TRUE; default) or should construct labels be shown for each row of the table (FALSE).

bold_headers Logical. Should column headers be bolded (default: TRUE)?

digits, decimal.mark, leading0, drop0integer, neg.sign, pos.sign, big.mark, big.interval, small.mark, small.interval Number formatting arguments. See `format_num` for details.

correction_type Has the meta-analytic corrections been included. Valid options are: "ts" (default), "vgx", and "vgy". Multiple options are permitted.

collapsable_labels Should the construct labels for construct pairs with multiple rows of results be simplified so that only the first occurrence of each set of construct names is shown (TRUE; default) or should construct labels be shown for each row of the table (FALSE).

bold_headers Logical. Should column headers be bolded (default: TRUE)?

digits, decimal.mark, leading0, drop0integer, neg.sign, pos.sign, big.mark, big.interval, small.mark, small.interval Number formatting arguments. See `format_num` for details.

correction_type How should confidence intervals be formatted? Options are:

- parentheses: Bounds are enclosed in parentheses and separated by a comma: (LO, UP).
- brackets: Bounds are enclosed in square brackets and separated by a comma: [LO, UP].
- columns: Bounds are shown in individual columns.

cred_format How should credibility intervals be formatted? Options are the same as for `conf_format` above.

symbol_es For meta-analyses of generic (non-r, non-d) effect sizes, the symbol used for the effect sizes (default: `symbol_es = "ES"`).

caption A list of YAML header parameters to pass to `link[rmarkdown]{render}`.

verbose Logical. Should detailed SD and variance components be shown (default: FALSE)?

unicode Logical. If `output_format` is "text", should UTF-8 characters be used (defaults to system default).

bib A BibTeX file containing the citekeys for the meta-analyses. If provided and file is not NULL, a bibliography will be included with the meta-analysis table. See `generate_bib` for additional arguments controlling the bibliography.

title.bib The title to give to the bibliography (see bib above). If NULL, defaults to "Sources Contributing to Meta-Analyses"
style

What style should the bibliography (see bib above) be formatted in? Can be a file path or URL for a CSL citation style or the style ID for any style available from the Zotero Style Repository). Defaults to APA style. (Retrieving a style by ID requires an internet connection. If unavailable, references will be rendered in Chicago style.).

additional_citekeys

Additional citekeys to include in the reference list (see bib above).

save_build_files

Should the RMarkdown and BibLaTeX (if any) files used to generate the output be saved (default: FALSE)?

Value

A list of meta-analysis results tibbles with "caption" and "footnote" attributes.

If file is specified, formatted tables and bibliographies are exported in the requested output_format.

Formatted tables of meta-analytic output.

See Also

Other output functions: generate_bib(), metabulate_rmd_helper()

Examples

## Not run:
## Create a results table for meta-analysis of correlations and output to Word:
ma_r_obj <- ma_r(ma_method = "ic", rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi,
construct_x = x_name, construct_y = y_name,
moderators = moderator, data = data_r_meas_multi)
metabulate(ma_obj = ma_r_obj, file = "meta tables correlations",
output_format = "word", output_dir = tempdir())

## Output to PDF:
metabulate(ma_obj = ma_r_obj, file = "meta tables correlations",
output_format = "pdf", output_dir = tempdir())

## Output to ODT (LibreOffice):
metabulate(ma_obj = ma_r_obj, file = "meta tables correlations",
output_format = "odt", output_dir = tempdir())

## To produce Markdown tables to include inline in an RMarkdown report,
## leave file == NULL and output_format to anything but "text":
ma_table <- metabulate(ma_obj = ma_r_obj, file = NULL, output_format = "rmd")

## Use the metabulate_rmd_helper() function to ensure all symbols render properly.
Insert the following code as 'as-is' output:
metabulate_rmd_helper()

## Then, add the formatted table to your document using your preferred table
## formatting functions:

#### Using just the ‘knitr’ package, include the following as ‘as-is’ output:

```r
knitr::kable(ma_table[[1]], caption = attr(ma_table[[1]], "caption"))
cat("\n", attr(ma_table[[1]], "footnote"))
```

#### Using ‘knitr’ plus the ‘kableExtra’ package:

```r
knitr::kable(ma_table[[1]], "latex", booktabs = TRUE,
    caption = attr(ma_table[[1]], "caption"))
    kableExtra::kable_styling(latex_options = c("striped", "hold_position"))
    kableExtra::footnote(general = attr(ma_table[[1]], "footnote"))
```

# Note: On Windows, R currently can only handle Unicode characters if kables # are printed at top-level (e.g., not in an if() statement, in a for() loop, # or in lapply() or map() ). To correctly print Unicode metabulate tables, call # kable() as a top-level function (as above).

## Create output table for meta-analysis of d values:

```r
ma_d_obj <- ma_d(ma_method = "ic", d = d, n1 = n1, n2 = n2, ryy = ryy,
    construct_y = construct, data = data_d_meas_multi)
ma_d_obj <- ma_d_ad(ma_obj = ma_d_obj, correct_rr_g = FALSE, correct_rr_y = FALSE)
metabulate(ma_obj = ma_d_obj, file = "meta tables d values", output_dir = tempdir())
```

## Create output table for meta-analysis of generic effect sizes:

```r
dat <- data.frame(es = data_r_meas_multi$rxyi,
    n = data_r_meas_multi$n,
    var_e = (1 - data_r_meas_multi$rxyi^2)^2 / (data_r_meas_multi$n - 1))
ma_obj <- ma_generic(es = es, n = n, var_e = var_e, data = dat)
metabulate(ma_obj = ma_obj, file = "meta tables generic es", output_dir = tempdir())
```

## End(Not run)

---

### metabulate_rmd_helper

**Add metabulate equation commands and LaTeX dependencies**

**Description**

The `metabulate` function requires several lines of code to correctly render meta-analysis results table column headings and footnotes. If `metabulate` is used to render files directly, these are added to the internal RMarkdown document. If you use `metabulate` output in a larger RMarkdown document, use this function to automatically add the necessary lines of code based on your chosen output format.

**Usage**

```r
metabulate_rmd_helper(latex = TRUE, html = TRUE, word_proc = TRUE)
```
Arguments

**latex**  Should required commands be included when converting to PDF, LaTeX, and related formats?

**html**  Should required commands be included when converting to HTML and related formats?

**word_proc**  Should required commands be included when converting to Word, ODT, and related formats?

Value

Requested commands are printed to the console.

**PDF and LaTeX output**

If **latex** is TRUE and you render to PDF, LaTeX, or other output formats requiring LaTeX (e.g., beamer_presentation, see `knitr::is_latex_output`), a YAML metadata block with a `header-includes` argument calling the required `unicode-math` LaTeX package is printed.

An R Markdown file can only include one `header-includes` metadata entry. If your document already has one, set `latex` to FALSE and manually add the `unicode-math` package to your LaTeX header instead.

(Note that `header-includes` is generally discouraged in favor of adding an include argument to specific output formats, see [http://rmarkdown.rstudio.com/pdf_document_format.html#includes](http://rmarkdown.rstudio.com/pdf_document_format.html#includes).)

**HTML output**

If **html** is TRUE and you render to HTML (or related formats, see `knitr::is_html_output`, the following LaTeX math commands are defined:

- symit
- symup
- symbfit
- symbfup

If you define your own LaTeX or MathJax macros for these commands, set `html` to FALSE.

**Microsoft Office and LibreOffice output**

If **word_proc** is TRUE and you render to Word or ODT (or related formats such as PowerPoint), the following LaTeX math commands are defined:

- symit
- symup
- symbfit
- symbfup

If you define your own LaTeX, Office, or OpenDocument macros for these commands, set `word_proc` to FALSE.
See Also

Other output functions: `generate_bib()`, `metabulate()`

Examples

```r
## Include this line as 'asis' output in your RMarkdown document:
metabulate_rmd_helper()

## If you've already included \usepackage{unicode-math} in your RMarkdown header
## for PDF (and related formats) header, set latex to FALSE:
metabulate_rmd_helper(latex = FALSE)
```

---

## metareg

### Compute meta-regressions

**Description**

This function is a wrapper for metafor’s `rma` function that computes meta-regressions for all bare-bones and individual-correction meta-analyses within an object. It makes use of both categorical and continuous moderator information stored in the meta-analysis object and allows for interaction effects to be included in the regression model. Output from this function will be added to the meta-analysis object in a list called `follow_up_analyses`. If using this function with a multi-construct meta-analysis object from `ma_r` or `ma_d`, note that the `follow_up_analyses` list is appended to the meta-analysis object belonging to a specific construct pair within the `construct_pairs` list.

**Usage**

```r
metareg(ma_obj, formula_list = NULL, ...)
```

**Arguments**

- `ma_obj`: Meta-analysis object.
- `formula_list`: Optional list of regression formulas to evaluate. NOTE: If there are spaces in your moderator names, replace them with underscores (i.e., "_" ) so that the formula(s) will perform properly. The function will remove spaces in the data, you only have to account for this in `formula_list` when you supply your own formula(s).
- `...`: Additional arguments.

**Value**

`ma_obj` with meta-regression results added (see `ma_obj$follow_up_analyses$metareg`).
mix_dist

Description

Compute descriptive statistics for a mixture distribution. This function returns the grand mean, the pooled sample variance (mean square within), variance of sample means (mean square between), portions of the total variance that are within and between groups, and mixture (total sample) variance of the mixture sample data.

Usage

mix_dist(mean_vec, var_vec, n_vec, unbiased = TRUE, na.rm = FALSE)
Arguments

- **mean_vec**: Vector of sample means.
- **var_vec**: Vector of sample variances.
- **n_vec**: Vector of sample sizes.
- **unbiased**: Logical scalar determining whether variance should be unbiased (TRUE; default) or maximum-likelihood (FALSE).
- **na.rm**: Logical scalar determining whether to remove missing values prior to computing output (TRUE) or not (FALSE; default)

Details

The grand mean of a mixture distribution is computed as:

$$
\mu = \frac{\sum_{i=1}^{k} \bar{x}_i n_i}{\sum_{i=1}^{k} n_i}
$$

where $\mu$ is the grand mean, $\bar{x}_i$ represents the sample means, and $n_i$ represents the sample sizes.

Maximum-likelihood mixture variances are computed as:

$$
var_{pooled_{ML}} = MSW_{ML} = \frac{\sum_{i=1}^{k} (\bar{x}_i - \mu) n_i}{\sum_{i=1}^{k} n_i}
$$

$$
var_{means_{ML}} = MSB_{ML} = \frac{\sum_{i=1}^{k} (\bar{x}_i - \mu) n_i}{k}
$$

$$
var_{BG_{ML}} = \frac{\sum_{i=1}^{k} (\bar{x}_i - \mu) n_i}{\sum_{i=1}^{k} n_i}
$$

$$
var_{WG_{ML}} = \frac{\sum_{i=1}^{k} v_i n_i}{\sum_{i=1}^{k} n_i}
$$

$$
var_{mix_{ML}} = var_{BG_{ML}} + var_{WG_{ML}}
$$

where $v_i$ represents the sample variances.

Unbiased mixture variances are computed as:

$$
var_{pooled_{Unbiased}} = MSW_{Unbiased} = \frac{\sum_{i=1}^{k} v_i (n_i - 1)}{(\sum_{i=1}^{k} n_i) - k}
$$

$$
var_{means_{Unbiased}} = MSB_{Unbiased} = \frac{\sum_{i=1}^{k} (\bar{x}_i - \mu) n_i}{k - 1}
$$

$$
var_{BG_{Unbiased}} = \frac{\sum_{i=1}^{k} (\bar{x}_i - \mu) n_i}{(\sum_{i=1}^{k} n_i) - 1}
$$

$$
var_{WG_{Unbiased}} = \frac{\sum_{i=1}^{k} v_i (n_i - 1)}{(\sum_{i=1}^{k} n_i) - 1}
$$

$$
var_{mix_{Unbiased}} = var_{BG_{Unbiased}} + var_{WG_{Unbiased}}
$$
Value

The mean, pooled sample (within-sample) variance, variance of sample means (between-groups),
and mixture (total sample) variance of the mixture sample data.

Examples

mix_dist(mean_vec = c(-.5, 0, .5), var_vec = c(.9, 1, 1.1), n_vec = c(100, 100, 100))

Description

Estimate mixture covariance matrix from within-group covariance matrices

Usage

mix_matrix(
  sigma_list,
  mu_mat,
  p_vec,
  N = Inf,
  group_names = NULL,
  var_names = NULL
)

Arguments

sigma_list List of covariance matrices.
mu_mat Matrix of mean parameters, with groups on the rows and variables on the columns.
p_vec Vector of proportion of cases in each group.
N Optional total sample size across all groups (used to compute unbiased covariance estimates).
group_names Optional vector of group names.
var_names Optional vector of variable names.

Value

List of mixture covariances and means.
Examples

```r
out <- unmix_matrix(sigma_mat = reshape_vec2mat(.5, order = 2),
                      mu_mat = rbind(c(0, 0), c(.5, 1)),
                      p_vec = c(.3, .7), N = 100)

mix_matrix(sigma_list = out$cov_group_unbiased,
           mu_mat = out$means_raw[-3,],
           p_vec = out$p_group, N = out$N)
```

---

mix_r_2group

Estimate the mixture correlation for two groups

Description

Estimate the mixture correlation for two groups

Usage

```r
mix_r_2group(rxy, dx, dy, p = 0.5)
```

Arguments

- `rxy`: Average within-group correlation
- `dx`: Standardized mean difference between groups on X.
- `dy`: Standardized mean difference between groups on Y.
- `p`: Proportion of cases in one of the two groups.

Details

The average within-group correlation is estimated as:

\[
\rho_{xyWG} = \rho_{xyMix} \sqrt{(d_x^2p(1-p) + 1)(d_y^2p(1-p) + 1) - \sqrt{d_x^2d_y^2p^2(1-p)^2}}
\]

where \(\rho_{xyWG}\) is the average within-group correlation, \(\rho_{xyMix}\) is the overall mixture correlation, \(d_x\) is the standardized mean difference between groups on X, \(d_y\) is the standardized mean difference between groups on Y, and \(p\) is the proportion of cases in one of the two groups.

Value

A vector of two-group mixture correlations

Examples

```r
mix_r_2group(rxy = .375, dx = 1, dy = 1, p = .5)
```
plot_forest  

Create forest plots

Description
Create forest plots

Usage
plot_forest(
  ma_obj,  
  analyses = "all",  
  match = c("all", "any"),  
  case_sensitive = TRUE,  
  show_filtered = FALSE,  
  ma_facetname = "Summary",  
  facet_levels = NULL,  
  conf_level = 0.95,  
  conf_method = "t",  
  x_limits = NULL,  
  x_breaks = NULL,  
  x_lab = NULL,  
  y_lab = "Reference"  
)

Arguments

ma_obj  
Meta-analysis object.

analyses  
Which analyses to extract? Can be either "all" to extract references for all
meta-analyses in the object (default) or a list containing arguments for [filter_ma].

match  
Should extracted meta-analyses match all (default) or any of the criteria given
in analyses?

case_sensitive  
Logical scalar that determines whether character values supplied in
analyses should be treated as case sensitive (TRUE, default) or not (FALSE).

show_filtered  
Logical scalar that determines whether the meta-analysis object given in the output
should be the modified input object (FALSE, default) or the filtered object (TRUE).

ma_facetname  
Label to use for meta-analysis results in the facet_grid() function from ggplot2.

facet_levels  
Order in which moderator levels should be displayed.

cnf_level  
Confidence level to define the width of the confidence interval (default = .95).

cnf_method  
Distribution to be used to compute the width of confidence intervals. Available
options are "t" for t distribution or "norm" for normal distribution.

x_limits  
Span of the X values to be plotted.
x_breaks  Breaks for the X values to be plotted.
x_lab      Label to use for the X axis.
y_lab      Label to use for the Y axis.

Value

A list of forest plots.

Author(s)

Based on code by John Sakaluk

Examples

```r
## Not run:
ma_obj <- ma_r(ma_method = "ic", rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi,
               construct_x = x_name, construct_y = y_name, sample_id = sample_id,
               moderators = moderator, data = data_r_meas_multi)
plot_forest(ma_obj = ma_obj)
plot_forest(ma_obj = ma_obj, analyses = list(pair_id = 2))
plot_forest(ma_obj = ma_obj, analyses = list(pair_id = 1), show_filtered = TRUE)
## d values
ma_obj <- ma_d(ma_method = "ic", d = d, n1 = n1, n2 = n2, ryy = ryyi,
               construct_y = construct, sample_id = sample_id,
               data = data_d_meas_multi)
plot_forest(ma_obj = ma_obj)
plot_forest(ma_obj = ma_obj, analyses = list(pair_id = 2))
plot_forest(ma_obj = ma_obj, analyses = list(pair_id = 1, analysis_id = 1), show_filtered = TRUE)
## End(Not run)
```

---

**Description**

This function creates funnel plots for meta-analyses (plots of effect size versus . Both traditional funnel plots and

**Usage**

```r
plot_funnel(
  ma_obj,
  se_type = c("auto", "mean", "sample"),
  label_es = NULL,
  conf_level = c(0.95, 0.99),
  conf_linetype = c("dashed", "dotted"),
```
Arguments

ma_obj  Meta-analysis object.
se_type  Method to calculate standard errors (y-axis). Options are "auto" (default) to use the same method as used to estimate the meta-analysis models, "mean" to calculate SEs using the mean effect size and individual sample sizes, or "sample" to use the SE calculated using the sample effect sizes and sample sizes.

label_es  Label for effect size (x-axis). Defaults to "Correlation (r)" for correlation meta-analyses, "Cohen’s d (Hedges’s g)" for d value meta-analyses, and "Effect size" for generic meta-analyses.

conf_level  Confidence regions levels to be plotted (default: .95, .99).
conf_linetype  Line types for confidence region boundaries. Length should be either 1 or equal to the length of conf_level.

conf_fill  Colors for confidence regions. Set to NA for transparent. Length should be either 1 or equal to the length of conf_level.
conf_alpha  Transparency level for confidence regions. Length should be either 1 or equal to the length of conf_level.

null_effect  Null effect to be plotted for contour-enhanced funnel plots. If NA, not shown. If NULL, set to the null value for the effect size metric (0 for correlations and d values).

null_conf_level  Null-effect confidence regions levels to be plotted (default: .90, .95, .99).

null_conf_linetype  Line types for null-effect confidence region boundaries. Length should be either 1 or equal to the length of null_conf_level.

null_conf_fill  Colors for null-effect confidence regions. Set to NA for transparent. Length should be either 1 or equal to the length of null_conf_level.

null_conf_alpha  Transparency level for null-effect confidence regions. Length should be either 1 or equal to the length of null_conf_level.

analyses  Which analyses to extract? Can be either "all" to extract references for all meta-analyses in the object (default) or a list containing arguments for filter_ma.

match  Should extracted meta-analyses match all (default) or any of the criteria given in analyses?

case_sensitive  Logical scalar that determines whether character values supplied in analyses should be treated as case sensitive (TRUE, default) or not (FALSE).

show_filtered  Logical scalar that determines whether the meta-analysis object given in the output should be the modified input object (FALSE, default) or the filtered object (TRUE).

Value

A list of funnel plots.

Author(s)

Based on code by John Sakaluk

Examples

```r
## Not run:
## Correlations
ma_obj <- ma_r(ma_method = "ic", rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi,
               construct_x = x_name, construct_y = y_name, sample_id = sample_id,
               moderators = moderator, data = data_r_meas_multi)
plot_funnel(ma_obj = ma_obj)
plot_funnel(ma_obj = ma_obj, analyses = list(pair_id = 2))
plot_funnel(ma_obj = ma_obj, analyses = list(pair_id = 1, analysis_id = 1), show_filtered = TRUE)

## d values
ma_obj <- ma_d(ma_method = "ic", d = d, n1 = n1, n2 = n2, ryy = ryyi,
               construct_y = construct, sample_id = sample_id,
               data = data_d_meas_multi)
```
plot_funnel(ma_obj = ma_obj)
plot_funnel(ma_obj = ma_obj, analyses = list(pair_id = 2))
plot_funnel(ma_obj = ma_obj, analyses = list(pair_id = 1, analysis_id = 1), show_filtered = TRUE)

## End(Not run)

### predict

**Prediction method for objects of classes deriving from "lm_mat"**

**Description**

Prediction method for objects of classes deriving from "lm_mat"

**Arguments**

- **object**: Object of class inheriting from "lm_mat"
- **newdata**: An optional data frame in which to look for variables with which to predict. If omitted, the fitted values are used.
- **se.fit**: A switch indicating if standard errors are required.
- **df**: Degrees of freedom for scale.
- **interval**: Type of interval calculation. Can be abbreviated.
- **level**: Tolerance/confidence level.
- **...**: further arguments passed to or from other methods.

**Value**

An set of predicted values

### print

**Print methods for psychmeta**

**Description**

Print methods for psychmeta output objects with classes exported from psychmeta.

**Arguments**

- **x**: Object to be printed (object is used to select a method).
- **...**: Additional arguments.
- **digits**: Number of digits to which results should be rounded.
- **n**: Number of rows to print for meta-analysis results tables. Defaults to all rows. See `tibble::print.tbl()` for details.
### psychmeta_news

**Description**

This function gives a shortcut to the `utils::news(package = "psychmeta")` function and displays `psychmeta`'s NEWS file, which contains version information, outlines additions and changes to the package, and describes other updates.

**Usage**

```r
calling_sequence
```

**Examples**

```r
psychmeta_news()
```

---

### reattribute

**Description**

Copy class and attributes from the original version of an object to a modified version.

**Usage**

```r
calling_sequence
```
**Arguments**

- **x** The original object, which has a class/attributes to copy
- **result** The modified object, which is / might be missing the class/attributes.

**Value**

result, now with class/attributes restored.

---

**reshape_mat2dat**  
*Extract a long-format correlation database from a correlation matrix and its supporting vectors/matrices of variable information*

**Description**

This function is designed to extract data from a correlation matrix that is in the format commonly published in journals, with leading columns of construct names and descriptive statistics being listed along with correlation data.

**Usage**

```r
reshape_mat2dat(
  var_names,
  cor_data,
  common_data = NULL,
  unique_data = NULL,
  diag_label = NULL,
  lower_tri = TRUE,
  data = NULL
)
```

**Arguments**

- **var_names** Vector (or scalar column name to match with data) containing variable names.
- **cor_data** Square matrix (or vector of column names to match with data) containing correlations among variables.
- **common_data** Vector or matrix (or vector of column names to match with data) of data common to both X and Y variables (e.g., sample size, study-wise moderators).
- **unique_data** Vector or matrix (or vector of column names to match with data) of data unique to X and Y variables (e.g., mean, SD, reliability).
- **diag_label** Optional name to attribute to values extracted from the diagonal of the matrix (if NULL, no values are extracted from the diagonal).
- **lower_tri** Logical scalar that identifies whether the correlations are in the lower triangle (TRUE) or in the upper triangle FALSE of the matrix.
- **data** Matrix, dataframe, or tibble containing study data (when present, column names of data will be matched to column names provided as other arguments).
Value

Long-format dataframe of correlation data, variable names, and supporting information

Author(s)

Jack W. Kostal

Examples

```r
## Create a hypothetical matrix of data from a small study:
mat <- data.frame(var_names = c("X", "Y", "Z"),
n = c(100, 100, 100),
mean = c(4, 5, 3),
sd = c(2.4, 2.6, 2),
rel = c(.8, .7, .85),
reshape_vec2mat(cov = c(.3, .4, .5)))
```

```r
## Arguments can be provided as quoted characters or as the unquoted names of data's columns:
reshape_mat2dat(var_names = var_names,
cor_data = c("Var1", "Var2", "Var3"),
common_data = "n",
unique_data = c("mean", "sd", "rel"),
data = mat)
```

```r
## Arguments can also provided as raw vectors, matrices, dataframes, etc. without a data argument:
reshape_mat2dat(var_names = mat[,1],
cor_data = mat[,6:8],
common_data = mat[,2],
unique_data = mat[,3:5])
```

```r
## If data is not null, arguments can be a mix of matrix/dataframe/vector and column-name arguments
reshape_mat2dat(var_names = mat[,1],
cor_data = mat[,6:8],
common_data = "n",
unique_data = c("mean", "sd", "rel"),
data = mat)
```

Description

The `reshape_vec2mat` function facilitates the creation of square correlation/covariance matrices from scalars or vectors of variances/covariances. It allows the user to supply a vector of covariances that make up the lower triangle of a matrix, determines the order of the matrix necessary to hold those covariances, and constructs a matrix accordingly.
reshape_vec2mat

Usage

reshape_vec2mat(
  cov = NULL,
  var = NULL,
  order = NULL,
  var_names = NULL,
  by_row = FALSE,
  diag = FALSE
)

Arguments

cov  Scalar or vector of covariance information to include the lower-triangle positions of the matrix (default value is zero). If a vector, the elements must be provided in the order associated with concatenated column (by_row = FALSE; default) or row (by_row = TRUE) vectors of the lower triangle of the desired matrix. If variances are included in these values, set the diag argument to TRUE.

var  Scalar or vector of variance information to include the diagonal positions of the matrix (default value is 1).

order  If cov and var are scalars, this argument determines the number of variables to create in the output matrix.

var_names  Optional vector of variable names.

by_row  Logical scalar indicating whether cov values should fill the lower triangle by row (TRUE) or by column (FALSE; default).

diag  Logical scalar indicating whether cov values include variances (FALSE by default; if TRUE, the variance values supplied with the cov argument will supersede the var argument).

Value

A variance-covariance matrix

Examples

## Specify the lower triangle covariances
## Can provide names for the variables
reshape_vec2mat(cov = c(.3, .2, .4), var_names = c("x", "y", "z"))

## Specify scalar values to repeat for the covariances and variances
reshape_vec2mat(cov = .3, var = 2, order = 3)

## Give a vector of variances to create a diagonal matrix
reshape_vec2mat(var = 1:5)

## Specify order only to create identity matrix
reshape_vec2mat(order = 3)

## Specify order and scalar variance to create a scalar matrix
reshape_vec2mat(var = 2, order = 3)

## A quick way to make a 2x2 matrix for bivariate correlations
reshape_vec2mat(cov = .2)

---

**reshape_wide2long**

### Description

This function automates the process of converting a wide-format database (i.e., a database in which intercorrelations between construct pairs define the columns, such that there are multiple columns of correlations) to a long-format database (i.e., a database with just one column of correlations). The meta-analysis functions in `psychmeta` work best with long-format databases, so this function can be a helpful addition to one’s workflow when data are organized in a wide format.

### Usage

```r
reshape_wide2long(
  data,
  common_vars = NULL,
  es_design = NULL,
  n_design = NULL,
  other_design = NULL,
  es_name = "rxyi",
  missing_col_action = c("warn", "ignore", "stop")
)
```

### Arguments

- **data**
  - Database of data for use in a meta-analysis in "wide" format.
- **common_vars**
  - String vector of column names relevant to all variables in data.
- **es_design**
  - p x p matrix containing the names of columns of intercorrelations among variables in the lower triangle of the matrix.
- **n_design**
  - Scalar sample-size column name or a p x p matrix containing the names of columns of sample sizes the lower triangle of the matrix.
- **other_design**
  - A matrix with variable names on the rows and names of long-format variables to create on the columns. Elements of this matrix must be column names of data.
- **es_name**
  - Name of the effect size represented in data.
- **missing_col_action**
  - Character scalar indicating how missing columns should be handled. Options are: "warn", "ignore", and "stop"

### Value

A long-format database
Examples

```
n_params = c(mean = 150, sd = 20)
rho_params <- list(c(.1, .3, .5),
  c(mean = .3, sd = .05),
  rbind(value = c(.1, .3, .5), weight = c(1, 2, 1)))
rel_params = list(c(.7, .8, .9),
  c(mean = .8, sd = .05),
  rbind(value = c(.7, .8, .9), weight = c(1, 2, 1)))
sr_params = c(list(1, 1, (.5, .7)))
sr_composite_params = list(1, c(.5, .6, .7))
w_t_params = list(list(c(1, 2, 3),
  c(mean = 2, sd = .25),
  rbind(value = c(1, 2, 3), weight = c(1, 2, 1))),
  list(c(1, 2, 3),
    c(mean = 2, sd = .25),
    rbind(value = c(1, 2, 3), weight = c(1, 2, 1))))
```  

```
## Simulate with wide format
data <- simulate_r_database(k = 10, n_params = n_params, rho_params = rho_params,
  rel_params = rel_params, sr_params = sr_params,
  sr_composite_params = sr_composite_params, wt_params = wt_params,
  var_names = c("X", "Y", "Z"), format = "wide")$statistics
```

```
## Define values to abstract from the data object
common_vars <- "sample_id"
es_design <- matrix(NA, 3, 3)
var_names <- c("X", "Y", "Z")
es_design[lower.tri(es_design)] <- c("rxyi_X_Y", "rxyi_X_Z", "rxyi_Y_Z")
rownames(es_design) <- colnames(es_design) <- var_names
n_design <- "ni"
other_design <- cbind(rxxi = paste0("parallel_rxxi_", var_names),
  ux_local = paste0("ux_local_", var_names),
  ux_external = paste0("ux_external_", var_names))
rownames(other_design) <- var_names

## Reshape the data to "long" format
reshape_wide2long(data = data, common_vars = common_vars, es_design = es_design,
  n_design = n_design, other_design = other_design)
```

**sensitivity**  
Sensitivity analyses for meta-analyses

**Description**

Wrapper function to compute bootstrap analyses, leave-one-out analyses, and cumulative meta-analyses. This function helps researchers to examine the stability/fragility of their meta-analytic results with bootstrapping and leave-one-out analyses, as well as detect initial evidence of publication bias with cumulative meta-analyses.
Usage

sensitivity(
  ma_obj,
  leave1out = TRUE,
  bootstrap = TRUE,
  cumulative = TRUE,
  sort_method = c("weight", "n", "inv_var"),
  boot_iter = 1000,
  boot_conf_level = 0.95,
  boot_ci_type = c("bca", "norm", "basic", "stud", "perc"),
  ...
)

sensitivity_bootstrap(
  ma_obj,
  boot_iter = 1000,
  boot_conf_level = 0.95,
  boot_ci_type = c("bca", "norm", "basic", "stud", "perc"),
  ...
)

sensitivity_cumulative(ma_obj, sort_method = c("weight", "n", "inv_var"), ...)

sensitivity_leave1out(ma_obj, ...)

Arguments

ma_obj  Meta-analysis object.
leave1out Logical scalar determining whether to compute leave-one-out analyses (TRUE) or not (FALSE).
bootstrap Logical scalar determining whether bootstrapping is to be performed (TRUE) or not (FALSE).
cumulative Logical scalar determining whether a cumulative meta-analysis is to be computed (TRUE) or not (FALSE).
sort_method Method to sort samples in the cumulative meta-analysis. Options are "weight" to sort by weight (default), "n" to sort by sample size, and "inv_var" to sort by inverse variance.
boot_iter Number of bootstrap iterations to be computed.
boot_conf_level Width of confidence intervals to be constructed for all bootstrapped statistics.
boot_ci_type Type of bootstrapped confidence interval. Options are "bca", "norm", "basic", "stud", and "perc" (these are "type" options from the boot::boot.ci function). Default is "bca". Note: If you have too few iterations, the "bca" method will not work and you will need to either increase the iterations or choose a different method.
...
Additional arguments.
### Value

An updated meta-analysis object with sensitivity analyses added.

- When bootstrapping is performed, the bootstrap section of the `follow_up_analyses` section of the updated `ma_obj` returned by this function will contain both a matrix summarizing the mean, variance, and confidence intervals of the bootstrapped samples and a table of meta-analytic results from all bootstrapped samples.
- When leave-one-out analyses are performed, the `ma_obj` will acquire a list of leave-one-out results in its `follow_up_analyses` section that contains a table of all leave-one-out meta-analyses along with plots of the mean and residual variance of the effect sizes in the meta-analyses.
- When cumulative meta-analysis is performed, the `ma_obj` will acquire a list of cumulative meta-analysis results in its `follow_up_analyses` section that contains a table of all meta-analyses computed along with plots of the mean and residual variance of the effect sizes in the meta-analyses, sorted by the order in which studies were added to the meta-analysis.

### Examples

```r
## Not run:
## Run a meta-analysis using simulated correlation data:
ma_obj <- ma_r_ic(rxyi = rxyi, n = n, rxx = rxxi, ryy = ryyi, ux = ux,
                  correct_rr_y = FALSE, data = data_r_uvirr)
ma_obj <- ma_r_ad(ma_obj, correct_rr_y = FALSE)
## Pass the meta-analysis object to the sensitivity() function:
ma_obj <- sensitivity(ma_obj = ma_obj, boot_iter = 10,
                      boot_ci_type = "norm", sort_method = "inv_var")
## Examine the tables and plots produced for the IC meta-analysis:
ma_obj$bootstrap[[1]]$barebones
ma_obj$bootstrap[[1]]$individual_correction$true_score
ma_obj$leave1out[[1]]$individual_correction$true_score
ma_obj$cumulative[[1]]$individual_correction$true_score

## Run a meta-analysis using simulated d-value data:
ma_obj <- ma_d_ic(d = d, n1 = n1, n2 = n2, ryy = ryyi,
                  data = filter(data_d_meas_multi, construct == "Y"))
ma_obj <- ma_d_ad(ma_obj)
## Pass the meta-analysis object to the sensitivity() function:
ma_obj <- sensitivity(ma_obj = ma_obj, boot_iter = 10,
                      boot_ci_type = "norm", sort_method = "inv_var")
## Examine the tables and plots produced for the IC meta-analysis:
ma_obj$bootstrap[[1]]$artifact_distribution$true_score
ma_obj$leave1out[[1]]$artifact_distribution$true_score
ma_obj$cumulative[[1]]$artifact_distribution$true_score
```

## Run a meta-analysis using simulated d-value data:
ma_obj <- ma_d_ic(d = d, n1 = n1, n2 = n2, ryy = ryyi,
                  data = filter(data_d_meas_multi, construct == "Y"))
ma_obj <- ma_d_ad(ma_obj)
## Pass the meta-analysis object to the sensitivity() function:
ma_obj <- sensitivity(ma_obj = ma_obj, boot_iter = 10,
                      boot_ci_type = "norm", sort_method = "inv_var")
## Examine the tables and plots produced for the IC meta-analysis:
ma_obj$bootstrap[[1]]$barebones
simulate_alpha

Generate a vector of simulated sample alpha coefficients

Description

This function generates inter-item covariance matrices from a population matrix and computes a coefficient alpha reliability estimate for each matrix.

Usage

simulate_alpha(
  item_mat = NULL,
  alpha = NULL,
  k_items = NULL,
  n_cases,
  k_samples,
  standarized = FALSE
)

Arguments

item_mat     Item correlation/covariance matrix. If item_mat is not supplied, the user must supply both alpha and k_items. If item_mat is NULL, the program will assume that all item intercorrelations are equal.
alpha        Population alpha value. Must be supplied if item_mat is NULL.
k_items      Number of items on the test to be simulated. Must be supplied if item_mat is NULL.
n_cases      Number of cases to simulate in sampling distribution of alpha.
k_samples    Number of samples to simulate.
standarized  Should alpha be computed from correlation matrices (TRUE) or unstandardized covariance matrices (FALSE)?

Value

A vector of simulated sample alpha coefficients
Examples

## Define a hypothetical matrix:
```r
item_mat <- reshape_vec2mat(cov = .3, order = 12)
```

## Simulations of unstandardized alphas
```r
set.seed(100)
simulate_alpha(item_mat = item_mat, n_cases = 50, k_samples = 10, standardized = FALSE)
```

```r
set.seed(100)
simulate_alpha(alpha = mean(item_mat[lower.tri(item_mat)]) / mean(item_mat),
               k_items = ncol(item_mat), n_cases = 50, k_samples = 10, standardized = FALSE)
```

## Simulations of standardized alphas
```r
set.seed(100)
simulate_alpha(item_mat = item_mat, n_cases = 50, k_samples = 10, standardized = TRUE)
```

```r
set.seed(100)
simulate_alpha(alpha = mean(item_mat[lower.tri(item_mat)]) / mean(item_mat),
               k_items = ncol(item_mat), n_cases = 50, k_samples = 10, standardized = TRUE)
```

---

**simulate_d_database**  
*Simulate d value databases of primary studies*

**Description**

The `simulate_d_database` function generates databases of psychometric d value data from sample-size parameters, correlation parameters, mean parameters, standard deviation parameters, reliability parameters, and selection-ratio parameters. The output database can be provided in a long format. If composite variables are to be formed, parameters can also be defined for the weights used to form the composites as well as the selection ratios applied to the composites. This function will return a database of statistics as well as a database of parameters - the parameter database contains the actual study parameters for each simulated sample without sampling error to allow comparisons between meta-analytic results computed from the statistics and the actual means and variances of parameters. The `merge_simdat_d` function can be used to merge multiple simulated databases and the `sparsify_simdat_d` function can be used to randomly delete artifact information (a procedure commonly done in simulations of artifact-distribution methods).

**Usage**

```r
simulate_d_database(
  k,  
n_params,  
rho_params,  
mu_params = NULL,  
sigma_params = 1,  
rel_params = 1,  
sr_params = 1,  
k_items_params = 1,  
wt_params = NULL,  
allow_neg_wt = FALSE,
```

```r```
simulate_d_database

sr_composite_params = NULL,
group_names = NULL,
var_names = NULL,
composite_names = NULL,
diffs_as_obs = FALSE,
show_applicant = FALSE,
keep_vars = NULL,
decimals = 2,
max_iter = 100,
...)

Arguments

k
Number of studies to simulate.

n_params
List of parameter distributions (or data-generation function; see details) for subgroup sample sizes.

rho_params
List containing a list of parameter distributions (or data-generation functions; see details) for correlations for each simulated group. If simulating data from a single fixed population matrix in each group, supply a list of those matrices for this argument (if the diagonals contains non-unity values and 'sigma_params' argument is not specified, those values will be used as variances).

mu_params
List containing a list of parameter distributions (or data-generation functions; see details) for means for each simulated group. If NULL, all means will be set to zero.

sigma_params
List containing a list of parameter distributions (or data-generation functions; see details) for standard deviations for each simulated group. If NULL, all standard deviations will be set to unity.

rel_params
List containing a list of parameter distributions (or data-generation functions; see details) for reliabilities for each simulated group. If NULL, all reliabilities will be set to unity.

sr_params
List of parameter distributions (or data-generation functions; see details) for selection ratios. If NULL, all selection ratios will be set to unity.

k_items_params
List of parameter distributions (or data-generation functions; see details) for the number of test items comprising each of the variables to be simulated (all are single-item variables by default).

wt_params
List of parameter distributions (or data-generation functions; see details) to create weights for use in forming composites. If multiple composites are formed, the list should be a list of lists, with the general format: list(comp1_params = list(...params...),comp2_params = list(...params...),etc.).

allow_neg_wt
Logical scalar that determines whether negative weights should be allowed (TRUE) or not (FALSE).

sr_composite_params
Parameter distributions (or data-generation functions; see details) for composite selection ratios.

group_names
Optional vector of group names.
var_names  Optional vector of variable names for all non-composite variables.
composite_names  Optional vector of names for composite variables.
diffs_as_obs  Logical scalar that determines whether standard deviation parameters represent
standard deviations of observed scores (TRUE) or of true scores (FALSE; default).
show_applicant  Should applicant data be shown for sample statistics (TRUE) or suppressed (FALSE)?
keep_vars  Optional vector of variable names to be extracted from the simulation and returned
in the output object. All variables are returned by default. Use this argument when only some variables are of interest and others are generated solely to
serve as selection variables.
decimals  Number of decimals to which statistical results (not parameters) should be rounded.
Rounding to 2 decimal places best captures the precision of data available from
published primary research.
max_iter  Maximum number of iterations to allow in the parameter selection process
before terminating with convergence failure. Must be finite.
...  Additional arguments.

Details

Values supplied as any argument with the suffix "params" can take any of three forms (see Examples
for a demonstration of usage):

- A vector of values from which study parameters should be sampled.
- A vector containing a mean with a variance or standard deviation. These values must be named
"mean," "var," and "sd", respectively, for the program to recognize which value is which.
- A matrix containing a row of values (this row must be named "values") from which study
parameters should be sampled and a row of weights (this row must be labeled 'weights')
associated with the values to be sampled.
- A matrix containing a column of values (this column must be named "values") from which
study parameters should be sampled and a column of weights (this column must be labeled
'weights') associated with the values to be sampled.
- A function that is configured to generate data using only one argument that defines the number
of cases to generate, e.g., fun(n = 10).

Value

A database of simulated primary studies' statistics and analytically determined parameter values.

Examples

```r
## Define sample sizes, means, and other parameters for each of two groups:
n_params <- list(c(mean = 200, sd = 20),
                 c(mean = 100, sd = 20))
rho_params <- list(list(c(.3, .4, .5)),
                   list(c(.3, .4, .5)))
mu_params <- list(list(c(mean = .5, sd = .5), c(-.5, 0, .5)),
                  list(c(mean = 0, sd = .5), c(-.2, 0, .2)))
```
simulate_d_sample

Simulate a sample of psychometric d value data with measurement error, direct range restriction, and/or indirect range restriction.

Description

This function generates a simulated psychometric sample consisting of any number of groups and computes the \(d\) values that result after introducing measurement error and/or range restriction.

Usage

```r
simulate_d_database(k = 5, n_params = n_params, rho_params = rho_params,
                  mu_params = mu_params, sigma_params = sigma_params,
                  rel_params = rel_params, sr_params = sr_params,
                  k_items = c(4, 4),
                  group_names = NULL, var_names = c("y1", "y2"),
                  show_applicant = TRUE, keep_vars = c("y1", "y2"), decimals = 2)
```

Arguments

- `n_vec`: Vector of sample sizes (or a vector of proportions, if parameters are to be estimated).
- `rho_mat_list`: List of true-score correlation matrices.
- `mu_mat`: Matrix of mean parameters, with groups on the rows and variables on the columns.
- `sigma_mat`: Matrix of standard-deviation parameters, with groups on the rows and variables on the columns.
- `rel_mat`: Matrix of correlation parameters, with groups on the rows and variables on the columns.
- `sr_vec`: Vector of range restriction parameters.
- `k_items_vec`: Vector of number of items per group.
- `wt_mat`: Optional weight matrix.
- `sr_composites`: Optional set of composite scores for range restriction.
- `group_names`: Optional vector of group names.
- `var_names`: Optional vector of variable names.
- `composite_names`: Optional vector of composite names.
- `diffs_as_obs`: Logical indicating whether differences should be observed.
simulate_matrix

This function generates simulated sample matrices based on a population matrix and a sample size. It uses the Wishart distribution (i.e., the multivariate $\chi^2$ distribution) to obtain data, rescales the data into the input metric, and can be standardized into a correlation matrix by setting `as_cor` to `TRUE`. The function can produce a list of matrices for any number of samples.

Value

A sample of simulated mean differences.

Examples

```r
## Simulate statistics by providing integers as "n_vec":
simulate_d_sample(n_vec = c(200, 100), rho_mat_list = list(reshape_vec2mat(.5), reshape_vec2mat(.4)), 
                   mu_mat = rbind(c(1, .5), c(0, 0)), sigma_mat = rbind(c(1, 1), c(1, 1)), 
                   rel_mat = rbind(c(.8, .7), c(.7, .7)), sr_vec = c(1, .5), 
                   group_names = c("A", "B"))

## Simulate parameters by providing proportions as "n_vec":
simulate_d_sample(n_vec = c(2/3, 1/3), rho_mat_list = list(reshape_vec2mat(.5), reshape_vec2mat(.4)), 
                   mu_mat = rbind(c(1, .5), c(0, 0)), sigma_mat = rbind(c(1, 1), c(1, 1)), 
                   rel_mat = rbind(c(.8, .7), c(.7, .7)), sr_vec = c(1, .5), 
                   group_names = c("A", "B"))
```

simulate_matrix

Generate a list of simulated sample matrices sampled from the Wishart distribution

Description

Matrix of reliability parameters, with groups on the rows and variables on the columns.

Vector of selection ratios.

Number of test items comprising each of the variables to be simulated (all are single-item variables by default).

Optional matrix of weights to use in forming a composite of the variables in `rho_mat`. Matrix should have as many rows (or vector elements) as there are variables in `rho_mat`.

Optional vector selection ratios for composite variables. If not `NULL`, `sr_composites` must have as many elements as there are columns in `wt_mat`.

Optional vector of group names.

Optional vector of variable names.

Optional vector of names for composite variables.

Logical scalar that determines whether standard deviation parameters represent standard deviations of observed scores (`TRUE`) or of true scores (`FALSE`; default).

A sample of simulated mean differences.
Usage

simulate_matrix(sigma, n, k = 1, as_cor = FALSE)

Arguments

sigma Population covariance matrix. May be standardized or unstandardized.
n Sample size for simulated sample matrices.
k Number of sample matrices to generate.
as_cor Should the simulated matrices be standardized (TRUE) or unstandardized (FALSE)?

Value

A list of simulated sample matrices.

Examples

## Define a hypothetical matrix:
sigma <- reshape_vec2mat(cov = .4, order = 5)
## Simualte a list of unstandardized covariance matrices:
simulate_matrix(sigma = sigma, n = 50, k = 10, as_cor = FALSE)
## Simualte a list of correlation matrices:
simulate_matrix(sigma = sigma, n = 50, k = 10, as_cor = TRUE)

simulate_psych

Simulate Monte Carlo psychometric data (observed, true, and error scores)

Description

Simulate Monte Carlo psychometric data (observed, true, and error scores)

Usage

simulate_psych(
  n,
  rho_mat,
  mu_vec = rep(0, ncol(rho_mat)),
  sigma_vec = rep(1, ncol(rho_mat)),
  rel_vec = rep(1, ncol(rho_mat)),
  sr_vec = rep(1, ncol(rho_mat)),
  k_items_vec = rep(1, ncol(rho_mat)),
  wt_mat = NULL,
  sr_composites = NULL,
  var_names = NULL,
  composite_names = NULL
)


simulate_psych

Arguments

- **n**: Number of cases to simulate before performing selection.
- **rho_mat**: Matrix of true-score correlations.
- **mu_vec**: Vector of means.
- **sigma_vec**: Vector of observed-score standard deviations.
- **rel_vec**: Vector of reliabilities corresponding to the variables in `rho_mat`.
- **sr_vec**: Vector of selection ratios corresponding to the variables in `rho_mat`. (set selection ratios to 1 for variables that should not be used in selection).
- **k_items_vec**: Number of test items comprising each of the variables to be simulated (all are single-item variables by default).
- **wt_mat**: Optional matrix of weights to use in forming a composite of the variables in `rho_mat`. Matrix should have as many rows (or vector elements) as there are variables in `rho_mat`.
- **sr_composites**: Optional vector selection ratios for composite variables. If not NULL, `sr_composites` must have as many elements as there are columns in `wt_mat`.
- **var_names**: Vector of variable names corresponding to the variables in `rho_mat`.
- **composite_names**: Optional vector of names for composite variables.

Value

A list of observed-score, true-score, and error-score data frames. If selection is requested, the data frames will include logical variables indicating whether each case would be selected on the basis of observed scores, true scores, or error scores.

Examples

```r
## Generate data for a simple sample with two variables without selection:
simulate_psych(n = 1000, rho_mat = matrix(c(1, .5, .5, 1), 2, 2), sigma_vec = c(1, 1),
                   rel_vec = c(.8, .8), var_names = c("Y", "X"))
```

```r
## Generate data for a simple sample with two variables with selection:
simulate_psych(n = 1000, rho_mat = matrix(c(1, .5, .5, 1), 2, 2), sigma_vec = c(1, 1),
                   rel_vec = c(.8, .8), sr_vec = c(1, .5), var_names = c("Y", "X"))
```

```r
## Generate data for samples with five variables, of which subsets are used to form composites:
rho_mat <- matrix(.5, 5, 5)
diag(rho_mat) <- 1
simulate_psych(n = 1000, rho_mat = rho_mat,
               rel_vec = rep(.8, 5), sr_vec = c(1, 1, 1, 1, .5),
               wt_mat = cbind(c(0, 0, .3, 1), c(1, .3, 0, 0)), sr_composites = c(.7, .5))
```

```r
## Generate data for similar scenario as above, but with scales consisting of 1-5 items:
rho_mat <- matrix(.5, 5, 5)
diag(rho_mat) <- 1
simulate_psych(n = 1000, rho_mat = rho_mat,
               rel_vec = rep(.8, 5), sr_vec = c(1, 1, 1, 1, .5),
               wt_mat = cbind(c(0, 0, .3, 1), c(1, .3, 0, 0)), sr_composites = c(.7, .5))
```
simulate_r_database

Simulate correlation databases of primary studies

Description

The `simulate_r_database` function generates databases of psychometric correlation data from sample-size parameters, correlation parameters, reliability parameters, and selection-ratio parameters. The output database can be provided in either a long format or a wide format. If composite variables are to be formed, parameters can also be defined for the weights used to form the composites as well as the selection ratios applied to the composites. This function will return a database of statistics as well as a database of parameters - the parameter database contains the actual study parameters for each simulated sample (without sampling error) to allow comparisons between meta-analytic results computed from the statistics and the actual means and variances of parameters. The `merge_simdat_r` function can be used to merge multiple simulated databases and the `sparsify_simdat_r` function can be used to randomly delete artifact information (a procedure commonly done in simulations of artifact-distribution methods).

Usage

```r
simulate_r_database(
  k,
  n_params,
  rho_params,
  mu_params = 0,
  sigma_params = 1,
  rel_params = 1,
  sr_params = 1,
  k_items_params = 1,
  wt_params = NULL,
  allow_neg_wt = FALSE,
  sr_composite_params = NULL,
  var_names = NULL,
  composite_names = NULL,
  n_as_ni = FALSE,
  show_applicant = FALSE,
  keep_vars = NULL,
  decimals = 2,
  format = "long",
  max_iter = 100,
  ...
)
```
Arguments

**k**  
Number of studies to simulate.

**n_params**  
Parameter distribution (or data-generation function; see details) for sample size.

**rho_params**  
List of parameter distributions (or data-generation functions; see details) for correlations. If simulating data from a single fixed population matrix, that matrix can be supplied for this argument (if the diagonal contains non-unity values and 'sigma_params' is not specified, those values will be used as variances).

**mu_params**  
List of parameter distributions (or data-generation functions; see details) for means.

**sigma_params**  
List of parameter distributions (or data-generation functions; see details) for standard deviations.

**rel_params**  
List of parameter distributions (or data-generation functions; see details) for reliabilities.

**sr_params**  
List of parameter distributions (or data-generation functions; see details) for selection ratios.

**k_items_params**  
List of parameter distributions (or data-generation functions; see details) for the number of test items comprising each of the variables to be simulated (all are single-item variables by default).

**wt_params**  
List of parameter distributions (or data-generation functions; see details) to create weights for use in forming composites. If multiple composites are formed, the list should be a list of lists, with the general format: `list(comp1_params = list(...params...),comp2_params = list(...params...),etc.`.

**allow_neg_wt**  
Logical scalar that determines whether negative weights should be allowed (TRUE) or not (FALSE).

**sr_composite_params**  
Parameter distributions (or data-generation functions; see details) for composite selection ratios.

**var_names**  
Optional vector of variable names for all non-composite variables.

**composite_names**  
Optional vector of names for composite variables.

**n_as_ni**  
Logical argument determining whether n specifies the incumbent sample size (TRUE) or the applicant sample size (FALSE; default). This can only be TRUE when only one variable is involved in selection.

**show_applicant**  
Should applicant data be shown for sample statistics (TRUE) or suppressed (FALSE)?

**keep_vars**  
Optional vector of variable names to be extracted from the simulation and returned in the output object. All variables are returned by default. Use this argument when only some variables are of interest and others are generated solely to serve as selection variables.

**decimals**  
Number of decimals to which statistical results (not parameters) should be rounded. Rounding to 2 decimal places best captures the precision of data available from published primary research.

**format**  
Database format: "long" or "wide."

**max_iter**  
Maximum number of iterations to allow in the parameter selection process before terminating with convergence failure. Must be finite.

...  
Additional arguments.
**Details**

Values supplied as any argument with the suffix "params" can take any of three forms (see Examples for a demonstration of usage):

- A vector of values from which study parameters should be sampled.
- A vector containing a mean with a variance or standard deviation. These values must be named "mean," "var," and "sd", respectively, for the program to recognize which value is which.
- A matrix containing a row of values (this row must be named "values") from which study parameters should be sampled and a row of weights (this row must be labeled 'weights') associated with the values to be sampled.
- A matrix containing a column of values (this column must be named "values") from which study parameters should be sampled and a column of weights (this column must be labeled 'weights') associated with the values to be sampled.
- A function that is configured to generate data using only one argument that defines the number of cases to generate, e.g., `fun(n = 10)`.

**Value**

A database of simulated primary studies’ statistics and analytically determined parameter values.

**Examples**

```r
## Note the varying methods for defining parameters:
n_params = function(n) rgamma(n, shape = 100)
rho_params <- list(c(.1, .3, .5),
               c(mean = .3, sd = .05),
               rbind(value = c(.1, .3, .5), weight = c(1, 2, 1)))
rel_params = list(c(.7, .8, .9),
               c(mean = .8, sd = .05),
               rbind(value = c(.7, .8, .9), weight = c(1, 2, 1)))
sr_params = c(list(1, 1, c(.5, .7)))
sr_composite_params = list(1, c(.5, .6, .7))
wt_params = list(list(c(1, 2, 3),
               c(mean = 2, sd = .25),
               rbind(value = c(1, 2, 3), weight = c(1, 2, 1))),
               list(c(1, 2, 3),
               c(mean = 2, sd = .25),
               cbind(value = c(1, 2, 3), weight = c(1, 2, 1))))

## Simulate with long format
simulate_r_database(k = 10, n_params = n_params, rho_params = rho_params,
                    rel_params = rel_params, sr_params = sr_params,
                    sr_composite_params = sr_composite_params, wt_params = wt_params,
                    var_names = c("X", "Y", "Z"), format = "long")

## Simulate with wide format
simulate_r_database(k = 10, n_params = n_params, rho_params = rho_params,
                    rel_params = rel_params, sr_params = sr_params,
                    sr_composite_params = sr_composite_params, wt_params = wt_params,
                    var_names = c("X", "Y", "Z"), format = "wide")
```
**simulate_r_sample**  
*Simulation of data with measurement error and range-restriction artifacts*

**Description**

This function simulates a psychometric sample and produces correlation matrices, artifact information, and other descriptive statistics that have been affected by measurement error and/or range restriction. It allows the formation of composite variables within the simulation and allows selection to be performed on any or all variables, including composites. By setting the sample size to \(n = \text{Inf}\), users can explore the effects of measurement error and/or range restriction on parameters without the influence of sampling error. To generate multiple samples and compile a database of simulated statistics, see the `simulate_r_database` function.

**Usage**

```r
simulate_r_sample(
  n,
  rho_mat,
  rel_vec = rep(1, ncol(rho_mat)),
  mu_vec = rep(0, ncol(rho_mat)),
  sigma_vec = rep(1, ncol(rho_mat)),
  sr_vec = rep(1, ncol(rho_mat)),
  k_items_vec = rep(1, ncol(rho_mat)),
  wt_mat = NULL,
  sr_composites = NULL,
  var_names = NULL,
  composite_names = NULL,
  n_as ни = FALSE,
  ...
)
```

**Arguments**

- **n**  
  Number of cases to simulate before performing selection. If `Inf`, function will simulate parameter values.

- **rho_mat**  
  Matrix of true-score correlations.

- **rel_vec**  
  Vector of reliabilities corresponding to the variables in `rho_mat`.

- **mu_vec**  
  Vector of means.

- **sigma_vec**  
  Vector of observed-score standard deviations.

- **sr_vec**  
  Vector of selection ratios corresponding to the variables in `rho_mat` (set selection ratios to 1 for variables that should not be used in selection).

- **k_items_vec**  
  Number of test items comprising each of the variables to be simulated (all are single-item variables by default).
sparsify_simdat_d

Create sparse artifact information in a "simdat_d_database" class object

Description

This function can be used to randomly delete artifact from databases produced by the simulate_d_database function. Deletion of artifacts can be performed in either a study-wise fashion for complete missingness within randomly selected studies or element-wise missingness for completely random deletion of artifacts in the database. Deletion can be applied to reliability estimates and/or u ratios.
Usage

```r
sparsify_simdat_d(
  data_obj,
  prop_missing,
  sparify_arts = c("rel", "u"),
  study_wise = TRUE
)
```

Arguments

- `data_obj`: Object created by the "simdat_d_database" function.
- `prop_missing`: Proportion of studies in from which artifact information should be deleted.
- `sparify_arts`: Vector of codes for the artifacts to be sparsified: "rel" for reliabilities, "u" for u ratios, or c("rel", "u") for both.
- `study_wise`: Logical scalar argument determining whether artifact deletion should occur for all variables in a study (TRUE) or randomly across variables within studies (FALSE).

Value

A sparsified database

---

**sparsify_simdat_r**

Create sparse artifact information in a "simdat_r_database" class object

Description

This function can be used to randomly delete artifact from databases produced by the `simulate_r_database` function. Deletion of artifacts can be performed in either a study-wise fashion for complete missingness within randomly selected studies or element-wise missingness for completely random deletion of artifacts in the database. Deletion can be applied to reliability estimates and/or u ratios.

Usage

```r
sparsify_simdat_r(
  data_obj,
  prop_missing,
  sparify_arts = c("rel", "u"),
  study_wise = TRUE
)
```
Arguments

- **data_obj**: Object created by the "simdat_r_database" function.
- **prop_missing**: Proportion of studies in from which artifact information should be deleted.
- **sparify_arts**: Vector of codes for the artifacts to be sparsified: "rel" for reliabilities, "u" for u ratios, or c("rel", "u") for both.
- **study_wise**: Logical scalar argument determining whether artifact deletion should occur for all variables in a study (TRUE) or randomly across variables within studies (FALSE).

Value

A sparsified database

---

### truncate_dist

**Truncation function for normal distributions (truncates both mean and variance)**

**Description**

This function computes the mean and variance of a normal distributions that has been truncated at one or both ends.

**Usage**

```r
truncate_dist(a = -Inf, b = Inf, mean = 0, sd = 1)
```
**Arguments**

- `a` Quantile (i.e., cut score) below which scores should be censored from the distribution.
- `b` Quantile (i.e., cut score) above which scores should be censored from the distribution.
- `mean` Scalar mean or vector of means.
- `sd` Scalar standard deviation or vector of standard deviations.

**Value**

A matrix of truncated means (column 1) and truncated variances (column 2).

**Examples**

```r
truncate_dist(a = -1, b = 3, mean = 0, sd = 1)
truncate_dist(a = 1, b = Inf, mean = 0, sd = 1)
truncate_dist(a = c(-1, 1), b = c(3, Inf), mean = 0, sd = 1)
```

---

**Description**

This function computes the mean of a normal distributions that has been truncated at one or both ends.

**Usage**

```r
truncate_mean(a = -Inf, b = Inf, mean = 0, sd = 1)
```

**Arguments**

- `a` Quantile (i.e., cut score) below which scores should be censored from the distribution.
- `b` Quantile (i.e., cut score) above which scores should be censored from the distribution.
- `mean` Scalar mean or vector of means.
- `sd` Scalar standard deviation or vector of standard deviations.

**Value**

A vector of truncated means.

**Examples**

```r
truncate_mean(a = -1, b = 3, mean = 0, sd = 1)
thru{c_1(e_1)}ntrac{e_2}e{2,1}_mean(a = 1, b = Inf, mean = 0, sd = 1)
thru{c_1(e_1)}ntrac{e_2}e{2,1}_mean(a = c(-1, 1), b = c(3, Inf), mean = 0, sd = 1)
```
### truncate_var

- **Truncation function for variances**

#### Description

This function computes the variance of a normal distribution that has been truncated at one or both ends.

#### Usage

```r
truncate_var(a = -Inf, b = Inf, mean = 0, sd = 1)
```

#### Arguments

- `a`: Quantile (i.e., cut score) below which scores should be censored from the distribution.
- `b`: Quantile (i.e., cut score) above which scores should be censored from the distribution.
- `mean`: Scalar mean or vector of means.
- `sd`: Scalar standard deviation or vector of standard deviations.

#### Value

A vector of truncated variances

#### Examples

```r
truncate_var(a = -1, b = 3, mean = 0, sd = 1)
truncate_var(a = 1, b = Inf, mean = 0, sd = 1)
truncate_var(a = c(-1, 1), b = c(3, Inf), mean = 0, sd = 1)
```

---

### unmix_matrix

- **Estimate average within-group covariance matrices from a mixture covariance matrix**

#### Description

Estimate average within-group covariance matrices from a mixture covariance matrix
Usage

unmix_matrix(
  sigma_mat,
  mu_mat,
  p_vec,
  N = Inf,
  group_names = NULL,
  var_names = NULL
)

Arguments

sigma_mat  Mixture covariance matrix.
mu_mat  Matrix of mean parameters, with groups on the rows and variables on the columns.
p_vec  Vector of proportion of cases in each group.
N  Optional total sample size across all groups (used to compute unbiased covariance estimates).
group_names  Optional vector of group names.
var_names  Optional vector of variable names.

Value

List of within-group covariances and means.

Examples

out <- unmix_matrix(sigma_mat = reshape_vec2mat(.5, order = 2),
  mu_mat = rbind(c(0, 0), c(.5, 1)),
  p_vec = c(.3, .7), N = 100)

## Result of unmix_matrix:
out

## Simulated data reproduce the total parameter matrix:
dat <- NULL
for(i in 1:2){
  dat <- rbind(dat, cbind(group = i,
    data.frame(MASS::mvrnorm(n = round(out$p_group[i] * out$N),
      mu = out$means_raw[i,],
      Sigma = out$cov_group_unbiased[[i]],
      empirical = TRUE))))
}
cov(dat[, -1])
unmix_r_2group | Estimate the average within-group correlation from a mixture correlation for two groups

Description
Estimate the average within-group correlation from a mixture correlation for two groups

Usage
unmix_r_2group(rxy, dx, dy, p = 0.5)

Arguments
- `rxy`: Overall mixture correlation.
- `dx`: Standardized mean difference between groups on X.
- `dy`: Standardized mean difference between groups on Y.
- `p`: Proportion of cases in one of the two groups.

Details
The mixture correlation for two groups is estimated as:
\[
\rho_{xyWG} = \frac{\rho_{xyMix} + \sqrt{d_x^2 d_y^2 p^2 (1 - p)^2}}{\sqrt{(d_x^2 p (1 - p) + 1) (d_y^2 p (1 - p) + 1)}}
\]

where \(\rho_{xyWG}\) is the average within-group correlation, \(\rho_{xyMix}\) is the overall mixture correlation, \(d_x\) is the standardized mean difference between groups on X, \(d_y\) is the standardized mean difference between groups on Y, and \(p\) is the proportion of cases in one of the two groups.

Value
A vector of average within-group correlations

References

Examples
unmix_r_2group(rxy = .5, dx = 1, dy = 1, p = .5)
Estimate the error variance of the probability-based effect size (A, AUC, the common language effect size [CLES])

Usage

```
var_error_A(A, n1, n2 = NA)
var_error_auc(A, n1, n2 = NA)
var_error_cles(A, n1, n2 = NA)
```

Arguments

- **A**: Vector of probability-based effect sizes (common language effect sizes)
- **n1**: Vector of sample sizes from group 1 (or the total sample size with the assumption that groups are of equal size, if no group 2 sample size is supplied).
- **n2**: Vector of sample sizes from group 2.

Details

The sampling variance of a A (also called AUC [area under curve] or CLES [common-language effect size]) value is:

\[
\left[ \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_1 n_2} \right] \frac{1}{12}
\]

When groups 1 and 2 are of equal size, this reduces to

\[
\left[ \frac{1}{n} + \frac{1}{n^2} \right] \frac{1}{3}
\]

Value

A vector of sampling-error variances.

References

Examples

```r
var_error_A(A = 1, n1 = 30, n2 = 30)
var_error_auc(A = 1, n1 = 60, n2 = NA)
var_error_cles(A = 1, n1 = 30, n2 = 30)
```

---

### Description

Analytic estimate of the sampling variance of alpha

### Usage

```r
var_error_alpha(item_mat = NULL, alpha = NULL, k_items = NULL, n_cases)
```

### Arguments

- `item_mat`: Item correlation/covariance matrix. If `item_mat` is not supplied, the user must supply both `alpha` and `k_items`. If `item_mat` is `NULL`, the program will assume that all item intercorrelations are equal.
- `alpha`: Vector of population alpha values. Must be supplied if `item_mat` is `NULL`.
- `k_items`: Vector of numbers of items to be simulated. Must be supplied if `item_mat` is `NULL`.
- `n_cases`: Vector of sample sizes to simulate in sampling distribution of alpha.

### Value

Vector of sampling variances of the supplied alpha(s).

### References


### Examples

```r
item_mat <- matrix(.3, 5, 5)
diag(item_mat) <- 1
alpha <- mean(item_mat[lower.tri(item_mat)]) / mean(item_mat)
k_items <- nrow(item_mat)

var_error_alpha(item_mat = item_mat, n_cases = 50)
var_error_alpha(alpha = alpha, k_items = k_items, n_cases = 50)
var_error_alpha(alpha = c(alpha, alpha), k_items = c(k_items, k_items), n_cases = 50)
```
Description

Allows for error variance to be estimated using total sample size of both groups being compared (in this case, supply sample sizes using only the n1 argument) or using separate sample sizes for group 1 and group 2 (i.e., the groups being compared; in this case, supply sample sizes using both the n1 and n2 arguments).

Usage

\texttt{var\_error\_d(d, n1, n2 = NA, correct\_bias = TRUE)}

Arguments

- \texttt{d} Vector of Cohen’s d values.
- \texttt{n1} Vector of sample sizes from group 1 (or the total sample size with the assumption that groups are of equal size, if no group 2 sample size is supplied).
- \texttt{n2} Vector of sample sizes from group 2.
- \texttt{correct\_bias} Logical argument that determines whether to correct error-variance estimates for small-sample bias in d values (TRUE) or not (FALSE).

Details

The sampling variance of a \( d \) value is:

\[
\frac{n - 1}{n - 3} \left( \frac{1}{n_1 n_2} + \frac{d^2}{2(n_1 + n_2)} \right)
\]

When groups 1 and 2 are of equal size, this reduces to

\[
var_e = \left( \frac{n - 1}{n - 3} \right) \left( \frac{4}{n} \right) \left( 1 + \frac{d^2}{8} \right)
\]

This can be corrected for bias by first correcting the \( d \) value (see \texttt{correct\_d\_bias}) prior to estimating the error variance.

Value

A vector of sampling-error variances.

References

var_error_delta

Examples

var_error_d(d = 1, n1 = 30, n2 = 30, correct_bias = TRUE)
var_error_d(d = 1, n1 = 60, n2 = NA, correct_bias = TRUE)

var_error_delta

Estimate the error variance of Glass’ delta values

Usage

var_error_delta(delta, nc, ne = NA, use_pooled_sd = FALSE, correct_bias = TRUE)

Arguments

delta Vector of Glass’ delta values.
nc Vector of control-group sample sizes (or the total sample size with the assumption that groups are of equal size, if no experimental-group sample size is supplied).
ne Vector of experimental-group sample sizes.
use_pooled_sd Logical vector determining whether the pooled standard deviation was used (TRUE) or not (FALSE). FALSE by default.
correct_bias Logical argument that determines whether to correct error-variance estimates for small-sample bias in d values (TRUE) or not (FALSE).

Value

A vector of sampling-error variances.

Examples

var_error_delta(delta = .3, nc = 30, ne = 30)
var_error_delta(delta = .3, nc = 60, ne = NA)
Estimate the error variance Hedges’s g values

Description

Allows for error variance to be estimated using total sample size of both groups being compared (in this case, supply sample sizes using only the n1 argument) or using separate sample sizes for group 1 and group 2 (i.e., the groups being compared; in this case, supply sample sizes using both the n1 and n2 arguments).

Usage

```r
var_error_g(g, n1, n2 = NA, a_method = c("gamma", "approx"))
```

Arguments

- `g`: Vector of Hedges’s g values.
- `n1`: Vector of sample sizes from group 1 (or the total sample size with the assumption that groups are of equal size, if no group 2 sample size is supplied).
- `n2`: Vector of sample sizes from group 2.
- `a_method`: Method used to correct the bias in Cohen’s d to convert to Hedges’s g. Options are "gamma" (default) for the exact method based on the gamma function (Hedges & Olkin, 1985) or "approx" for the computationally trivial approximation (Borenstein et al., 2006).

Value

A vector of sampling-error variances.

References


Examples

```r
var_error_g(g = 1, n1 = 30, n2 = 30)
var_error_g(g = 1, n1 = 60, n2 = NA)
```
Estimate the error variance of multiple correlations and squared multiple correlations for linear regressions

**Usage**

```r
var_error_mult_R(R, n, p)
```

```r
var_error_mult_Rsq(Rsq, n, p)
```

```r
var_error_R(R, n, p)
```

```r
var_error_Rsq(Rsq, n, p)
```

**Arguments**

- `R`: Vector of multiple correlation coefficients.
- `n`: Vector of sample sizes.
- `p`: Vector of numbers of predictors in the model.
- `Rsq`: Vector of squared multiple correlation coefficients.

**Details**

The sampling variance of a multiple correlation is approximately:

\[
\text{var}_e = \frac{(1 - R^2)^2(n - p - 1)^2}{(n^2 - 1)(n + 3)}
\]

The sampling variance of a squared multiple correlation is approximately:

\[
\text{var}_e = \frac{4R^2(1 - R^2)^2(n - p - 1)^2}{(n^2 - 1)(n + 3)}
\]

**Value**

A vector of sampling-error variances.

**References**


var_error_q

Examples

var_error_mult_R(R = .5, n = 30, p = 4)
var_error_mult_R(R = .5, n = 30, p = 4)
var_error_mult_Rsq(Rsq = .25, n = 30, p = 4)
var_error_mult_Rsq(Rsq = .25, n = 30, p = 4)

---

var_error_q

Estimate the error variance of square roots of reliability estimates

Description

Estimate the error variance of square roots of reliability estimates

Usage

var_error_q(q, n, rel_type = "alpha", k_items = NULL)

Arguments

q Vector of square roots of reliability estimates.
n Vector of sample sizes.
rel_type Character vector indicating the type(s) of reliabilities being analyzed. See documentation for ma_r for a full list of acceptable reliability types. NOTE: Currently, only alpha has its own dedicated error-variance estimate; the error variance of other reliability types is estimated using the generic definition of reliability as the squared correlation between observed scores and true scores.
k_items Optional numeric vector indicating the number of items in each scale for which reliabilities are being analyzed.

Details

The sampling variance of the square root of a reliability coefficient is:

\[
\text{var}_e = \frac{(1 - q_X^2)^2}{n - 1}
\]

For the equation to estimate the variance of coefficient alpha, see Duhachek and Iacobucci (2004).

Value

A vector of sampling-error variances.
References

Dahlke, J. A., & Wiernik, B. M. (2017). One of these artifacts is not like the others: New methods to account for the unique implications of indirect range-restriction corrections in organizational research. Unpublished manuscript.


Examples

```r
var_error_q(q = .8, n = 100)
var_error_q(q = .8, n = 100, rel_type = "alpha", k_items = 10)
```

---

**var_error_r**  
Estimate the error variance of correlations

**Description**

Estimate the error variance of correlations

**Usage**

```r
var_error_r(r, n, correct_bias = TRUE)
```

**Arguments**

- `r` Vector of correlations.
- `n` Vector of sample sizes.
- `correct_bias` Logical argument that determines whether to correct error-variance estimates for small-sample bias in correlations (TRUE) or not (FALSE).

**Details**

The sampling variance of a correlation is:

\[
\text{var}_e = \frac{(1 - r^2)^2}{n - 1}
\]

This can be corrected for bias by first correcting the correlation (see `correct_r_bias`) prior to estimating the error variance.

**Value**

A vector of sampling-error variances.
References


Examples

```r
var_error_r(r = .3, n = 30, correct_bias = TRUE)
var_error_r(r = .3, n = 30, correct_bias = FALSE)
```

---

**var_error_rel**

Estimate the error variance of reliability estimates

### Description

Estimate the error variance of reliability estimates

### Usage

```r
var_error_rel(rel, n, rel_type = "alpha", k_items = NULL)
```

### Arguments

- `rel`: Vector of reliability estimates.
- `n`: Vector of sample sizes.
- `rel_type`: Character vector indicating the type(s) of reliabilities being analyzed. See documentation for `ma_r` for a full list of acceptable reliability types. NOTE: Currently, only alpha has its own dedicated error-variance estimate; the error variance of other reliability types is estimated using the generic definition of reliability as the squared correlation between observed scores and true scores.
- `k_items`: Optional numeric vector indicating the number of items in each scale for which reliabilities are being analyzed.

### Details

The sampling variance of a reliability coefficient is:

\[
var_e = \frac{4r_{XX}(1 - r_{XX})^2}{n - 1}
\]

For the equation to estimate the variance of coefficient alpha, see Duhachek and Iacobucci (2004).

### Value

A vector of sampling-error variances.
References

Dahlke, J. A., & Wiernik, B. M. (2017). One of these artifacts is not like the others: New methods to account for the unique implications of indirect range-restriction corrections in organizational research. Unpublished manuscript.


Examples

```r
var_error_rel(rel = .8, n = 100)
var_error_rel(rel = .8, n = 100, rel_type = "alpha", k_items = 10)
```

var_error_r_bvirr

Taylor series approximation of the sampling variance of correlations corrected using the Case V correction for indirect range restriction

Description

This function propagates error in the bivariate indirect range-restriction correction formula to allow for the computation of a pseudo compound attenuation factor in individual-correction meta-analysis. Traditional methods for estimating compound attenuation factors (i.e., dividing the observed correlation by the corrected correlation) do not work with the BVIRR correction because BVIRR has an additive term that makes the corrected correlation inappropriate for use in estimating the effect of the correction on the variance of the sampling distribution of correlations. The equation-implied adjustment for the BVIRR correction (i.e., the first derivative of the correction equation with respect to the observed correlation) underestimates the error of corrected correlations, so this function helps to account for that additional error.

Usage

```r
var_error_r_bvirr(
  rxyi,
  var_e = NULL,
  ni,
  na = NA,
  ux = rep(1, length(rxyi)),
  ux_observed = rep(TRUE, length(rxyi)),
  uy = rep(1, length(rxyi)),
  uy_observed = rep(TRUE, length(rxyi)),
  qx = rep(1, length(rxyi)),
  qx_restricted = rep(TRUE, length(rxyi)),
  qx_type = rep("alpha", length(rxyi)),
  k_items_x = rep(NA, length(rxyi)),
  qy = rep(1, length(rxyi)),
  qy_restricted = rep(TRUE, length(rxyi)),
)```


```r
qy_type = rep("alpha", length(rxyi)),
k_items_y = rep(NA, length(rxyi)),
mean_rxyi = NULL,
mean_ux = NULL,
mean_qxa = NULL,
mean_qya = NULL,
var_rxyi = NULL,
var_ux = NULL,
var_qxa = NULL,
var_qya = NULL,
cor_rxyi_ux = 0,
cor_rxyi_uy = 0,
cor_rxyi_qxa = 0,
cor_rxyi_qya = 0,
cor_qxa_qya = 0,
sign_rxz = 1,
sign_ryz = 1,
r_deriv_only = FALSE)
```

**Arguments**

- `rxyi` Vector of observed correlations.
- `var_e` Vector of estimated sampling variances for rxyi values.
- `ni` Vector of incumbent sample sizes (necessary when variances of correlations/artifacts are not supplied).
- `na` Optional vector of applicant sample sizes (for estimating error variance of u ratios and applicant reliabilities).
- `ux` Vector of observed-score u ratios for X.
- `ux_observed` Logical vector in which each entry specifies whether the corresponding ux value is an observed-score u ratio (TRUE) or a true-score u ratio. All entries are `TRUE` by default.
- `uy` Vector of observed-score u ratios for Y.
- `uy_observed` Logical vector in which each entry specifies whether the corresponding uy value is an observed-score u ratio (TRUE) or a true-score u ratio. All entries are `TRUE` by default.
- `qx` Vector of square roots of reliability estimates for X.
- `qx_restricted` Logical vector determining whether each element of qx is derived from an incumbent reliability (TRUE) or an applicant reliability (FALSE).
qx_type, qy_type
String vector identifying the types of reliability estimates supplied (e.g., "alpha", "retest", "interrater_r", "splithalf"). See the documentation for ma_r for a full list of acceptable reliability types.

k_items_x, k_items_y
Numeric vector identifying the number of items in each scale.

qy
Vector of square roots of reliability estimates for X.

qy_restricted
Logical vector determining whether each element of qy is derived from an incumbent reliability (TRUE) or an applicant reliability (FALSE).

mean_rxyi
Mean observed correlation.

mean_ux
Mean observed-score u ratio for X (for use in estimating sampling errors in the context of a meta-analysis).

mean_uy
Mean observed-score u ratio for Y (for use in estimating sampling errors in the context of a meta-analysis).

mean_qxa
Mean square-root applicant reliability estimate for X (for use in estimating sampling errors in the context of a meta-analysis).

mean_qya
Mean square-root applicant reliability estimate for Y (for use in estimating sampling errors in the context of a meta-analysis).

var_rxyi
Optional pre-specified variance of correlations.

var_ux
Optional pre-specified variance of observed-score u ratios for X.

var_uy
Optional pre-specified variance of observed-score u ratios for Y.

var_qxa
Optional pre-specified variance of square-root applicant reliability estimate for X.

var_qya
Optional pre-specified variance of square-root applicant reliability estimate for Y.

cor_rxyi_ux
Correlation between rxyi and ux (zero by default).

cor_rxyi_uy
Correlation between rxyi and uy (zero by default).

cor_rxyi_qxa
Correlation between rxyi and qxa (zero by default).

cor_rxyi_qya
Correlation between rxyi and qya (zero by default).

cor_ux_uy
Correlation between ux and uy (zero by default).

cor_ux_qxa
Correlation between ux and qxa (zero by default).

cor_ux_qya
Correlation between ux and qya (zero by default).

cor_uy_qxa
Correlation between uy and qxa (zero by default).

cor_uy_qya
Correlation between uy and qya (zero by default).

cor_qxa_qya
Correlation between qxa and qya (zero by default).

sign_rxz
Sign of the relationship between X and the selection mechanism.

sign_ryz
Sign of the relationship between Y and the selection mechanism.

r_deriv_only
Logical scalar determining whether to use the partial derivative with respect to rxyi only (TRUE) or a full Taylor series approximation of the disattenuation formula (FALSE).
Details

Per the principles of propagation of uncertainty and assuming that $q_X$, $q_Y$, $u_X$, $u_Y$, and $\rho_{XY}$, are independent, we can derive a linear approximation of the sampling error of $\rho_{TP_a}$. We begin with the bivariate indirect range restriction formula,

$$\rho_{TP_a} = \frac{\rho_{XY}u_Xu_Y + \lambda \sqrt{1-u_X^2}\sqrt{1-u_Y^2}}{q_Xq_Y}$$

which implies the following linear approximation of the sampling variance of $\rho_{TP_a}$:

$$SE^2_{\rho_{TP_a}} = b_1^2SE^2_{q_X} + b_2^2SE^2_{q_Y} + b_3^2SE^2_{u_X} + b_4^2SE^2_{u_Y} + b_5^2SE^2_{\rho_{XY}}$$

where $b_1$, $b_2$, $b_3$, $b_4$, and $b_5$ are the first-order partial derivatives of the disattenuation formula with respect to $q_X$, $q_Y$, $u_X$, $u_Y$, and $\rho_{XY}$, respectively. These partial derivatives are computed as follows:

$$b_1 = \frac{\partial \rho_{TP_a}}{\partial q_X} = \frac{-\rho_{TP_a} q_X}{q_X}$$

$$b_2 = \frac{\partial \rho_{TP_a}}{\partial q_Y} = \frac{-\rho_{TP_a} q_Y}{q_Y}$$

$$b_3 = \frac{\partial \rho_{TP_a}}{\partial u_X} = \left[ \rho_{XY}u_Y - \frac{\lambda u_X (1-u_X^2) \sqrt{1-u_X^2}}{|1-u_X^2|^{1.5}} \right] / (q_Xq_Y)$$

$$b_4 = \frac{\partial \rho_{TP_a}}{\partial u_Y} = \left[ \rho_{XY}u_X - \frac{\lambda u_Y (1-u_Y^2) \sqrt{1-u_Y^2}}{|1-u_Y^2|^{1.5}} \right] / (q_Xq_Y)$$

$$b_5 = \frac{\partial \rho_{TP_a}}{\partial \rho_{XY}} = \frac{u_Xu_Y}{q_Xq_Y}$$

Value

A vector of corrected correlations’ sampling-error variances.

References

Dahlke, J. A., & Wiernik, B. M. (2018). One of these artifacts is not like the others: Accounting for indirect range restriction in organizational and psychological research. Manuscript submitted for review.

Examples

```r
var_error_r_bvirr(rxyi = .3, var_e = var_error_r(r = .3, n = 100), ni = 100, ux = .8, uy = .8, qx = .9, qx_restricted = TRUE, qy = .9, qy_restricted = TRUE, sign_rxz = 1, sign_ryz = 1)
```
**Description**

Estimate the error variance of u ratios

**Usage**

```r
var_error_u(u, ni, na = NA, dependent_sds = FALSE)
```

**Arguments**

- `u` Vector of u ratios.
- `ni` Vector of incumbent-group sample sizes.
- `na` Vector of applicant-group sample sizes.
- `dependent_sds` Logical vector identifying whether each u ratio is based on standard deviations from independent samples (FALSE) or based on standard deviations from an applicant sample and an incumbent sample that is a subset of that applicant sample (TRUE).

**Details**

The sampling variance of a u ratio is computed differently for independent samples (i.e., settings where the referent unrestricted standard deviation comes from a different sample than the range-restricted standard deviation) than for dependent samples (i.e., unrestricted samples from which a subset of individuals are selected to be in the incumbent sample).

The sampling variance for independent samples (the more common case) is:

\[
\text{var}_e = \frac{u^2}{2} \left( \frac{1}{n_i - 1} + \frac{1}{n_a - 1} \right)
\]

and the sampling variance for dependent samples is:

\[
\text{var}_e = \frac{u^2}{2} \left( \frac{1}{n_i - 1} - \frac{1}{n_a - 1} \right)
\]

where \(u\) is the u ratio, \(n_i\) is the incumbent sample size, and \(n_a\) is the applicant sample size.

**Value**

A vector of sampling-error variances.

**References**

Dahlke, J. A., & Wiernik, B. M. (2018). *One of these artifacts is not like the others: Accounting for indirect range restriction in organizational and psychological research*. Manuscript submitted for review.
Examples

var_error_u(u = .8, ni = 100, na = 200)
var_error_u(u = .8, ni = 100, na = NA)

wt_cov

Compute weighted covariances

Description

Compute the weighted covariance among variables in a matrix or between the variables in two separate matrices/vectors.

Usage

wt_cov(
  x,
  y = NULL,
  wt = NULL,
  as_cor = FALSE,
  use = c("everything", "listwise", "pairwise"),
  unbiased = TRUE,
  df_type = c("count", "sum_wts")
)

wt_cor(x, y = NULL, wt = NULL, use = "everything")

Arguments

x Vector or matrix of x variables.
y Vector or matrix of y variables
wt Vector of weights
as_cor Logical scalar that determines whether the covariances should be standardized (TRUE) or unstandardized (FALSE).
use Method for handling missing values. "everything" uses all values and does not account for missingness, "listwise" uses only complete cases, and "pairwise" uses pairwise deletion.
unbiased Logical scalar determining whether variance should be unbiased (TRUE) or maximum-likelihood (FALSE).
df_type Character scalar determining whether the degrees of freedom for unbiased estimates should be based on numbers of cases (n - 1; "count"; default) or squared sums of weights (1 - sum(w^2); "sum_wts")

Value

Scalar, vector, or matrix of covariances.
Examples

```r
wt_cov(x = c(1, 0, 2), y = c(1, 2, 3), wt = c(1, 2, 2), as_cor = FALSE, use = "everything")
wt_cov(x = c(1, 0, 2), y = c(1, 2, 3), wt = c(1, 2, 2), as_cor = TRUE, use = "everything")
wt_cov(x = cbind(c(1, 0, 2), c(1, 2, 3)), wt = c(1, 2, 2), as_cor = FALSE, use = "everything")
wt_cov(x = cbind(c(1, 0, 2), c(1, 2, 3)), wt = c(1, 2, 2), as_cor = TRUE, use = "everything")
wt_cov(x = cbind(c(1, 0, 2, NA), c(1, 2, 3, 3)), 
       wt = c(1, 2, 2, 1), as_cor = FALSE, use = "listwise")
wt_cov(x = cbind(c(1, 0, 2, NA), c(1, 2, 3, 3)), 
       wt = c(1, 2, 2, 1), as_cor = TRUE, use = "listwise")
```

**wt_dist**

Weighted descriptive statistics for a vector of numbers

Description

Compute the weighted mean and variance of a vector of numeric values. If no weights are supplied, defaults to computing the unweighted mean and the unweighted maximum-likelihood variance.

Usage

```r
wt_dist(
  x,
  wt = rep(1, length(x)),
  unbiased = TRUE,
  df_type = c("count", "sum_wts")
)
```

```r
wt_mean(x, wt = rep(1, length(x)))
```

```r
wt_var(
  x,
  wt = rep(1, length(x)),
  unbiased = TRUE,
  df_type = c("count", "sum_wts")
)
```

Arguments

- `x` Vector of values to be analyzed.
- `wt` Weights associated with the values in x.
- `unbiased` Logical scalar determining whether variance should be unbiased (TRUE) or maximum-likelihood (FALSE).
- `df_type` Character scalar determining whether the degrees of freedom for unbiased estimates should be based on numbers of cases ("count"; default) or sums of weights ("sum_wts").
The weighted mean is computed as

$$\bar{x}_w = \frac{\sum_{i=1}^{k} x_i w_i}{\sum_{i=1}^{k} w_i}$$

where \(x\) is a numeric vector and \(w\) is a vector of weights.

The weighted variance is computed as

$$\text{var}_w(x) = \frac{\sum_{i=1}^{k} (x_i - \bar{x}_w)^2 w_i}{\sum_{i=1}^{k} w_i}$$

and the unbiased weighted variance is estimated by multiplying \(\text{var}_w(x)\) by \(\frac{k}{k-1}\).

**Value**

A weighted mean and variance if weights are supplied or an unweighted mean and variance if weights are not supplied.

**Examples**

```r
wt_dist(x = c(.1, .3, .5), wt = c(100, 200, 300))
wt_mean(x = c(.1, .3, .5), wt = c(100, 200, 300))
wt_var(x = c(.1, .3, .5), wt = c(100, 200, 300))
```
Index

*Topic **datagen**
  - simulate_d_database, 191
  - simulate_psych, 196
  - simulate_r_database, 198
  - simulate_r_sample, 201

*Topic **datasets**
  - data_d_bb_multi, 68
  - data_d_meas_multi, 69
  - data_r_bvdr, 70
  - data_r_gonzalezmu_2014, 70
  - data_r_mcdaniel_1994, 71
  - data_r_mcleod, 71
  - data_r_meas, 72
  - data_r_meas_multi, 72
  - data_r_of_2009, 73
  - data_r_roth_2015, 73
  - data_r_uvdrr, 74
  - data_r_uvirr, 74

*Topic **distribution**
  - simulate_alpha, 190
  - simulate_matrix, 195

*Topic **regression**
  - metareg, 172

*Topic **univar**
  - mix_dist, 173
  - truncate_dist, 204
  - truncate_mean, 205
  - truncate_var, 206
  - wt_dist, 224

*Topic **utilities**
  - generate_directory, 116
    - ma_r_order2, 7
    - tau_squared_m_solver, 7
    - tau_squared_r_solver, 8
  - adjust_n_d, 9
  - adjust_n_r, 10
  - anova_ma_psychmeta, 11
  - composite_d_matrix, 12
  - composite_d_scalar, 13
  - composite_r_matrix, 14, 16
  - composite_r_scalar, 14, 17
  - composite_rel_matrix, 14
  - composite_rel_scalar, 15
  - composite_u_matrix, 19
  - composite_u_scalar, 20
  - compute_alpha, 21
  - compute_dmod, 21
  - compute_dmod_npar, 24
  - compute_dmod_par, 27
  - conf.limits.nc.chisq, 29
  - confidence, 31
  - confidence_r, 32
  - confint, 32
  - control_intercor, 33
  - control_psychmeta, 35
  - convert_es, 5, 38
  - convert_ma, 6, 40
  - convert_meta(convert_ma), 40
  - convert_d, 5, 41
  - correct_d, 5, 44, 211
  - correct_glass, 44, 211
  - correct_glassbias, 45
  - correct_matrix_mvrr, 46
  - correct_means_mvrr, 47
  - correct_r, 5, 48
  - correct_r(), 41
  - correct_r_bias, 51, 216
  - correct_r_coarseness, 52
  - correct_r_dich, 54
  - correct_r_split, 55
  - create_ad, 5, 56, 86, 152
  - create_ad_group, 61
  - create_ad_list(create_ad_tibble), 63
  - create_ad_tibble, 63
  - credibility, 67
  - data_d_bb_multi, 68
  - data_d_meas_multi, 6, 69
INDEX

data_r_bvdrr, 6, 69
data_r_bvirr, 6, 70
data_r_gonzalezmule_2014, 5, 70
data_r_mcdaniel_1994, 5, 71
data_r_mcleod_2007, 71
data_r_meas, 6, 72
data_r_meas_multi, 6, 72
data_r_oh_2009, 73
data_r_roth_2015, 5, 73
data_r_uvdrr, 6, 74
data_r_uvirr, 6, 74
estimate_artifacts, 75
estimate_cor_prods (estimate_prod), 80
estimate_cov_prods (estimate_prod), 80
estimate_length_sb, 79
estimate_mean_prod (estimate_prod), 80
estimate_prod, 80
estimate_q_dist, 82
estimate_rel_dist, 82
estimate_rel_sb, 83
estimate_rxaxa (estimate_artifacts), 75
estimate_rxaxa_u (estimate_artifacts), 75
estimate_rxxi (estimate_artifacts), 75
estimate_rxxi_u (estimate_artifacts), 75
estimate_ryya (estimate_artifacts), 75
estimate_ryyi (estimate_artifacts), 75
estimate_u, 84
estimate_up (estimate_artifacts), 75
estimate_ut (estimate_artifacts), 75
estimate_ux (estimate_artifacts), 75
estimate_uy (estimate_artifacts), 75
estimate_var_artifacts, 86
estimate_var_prod (estimate_prod), 80
estimate_var_qxa
(estimate_var_artifacts), 86
estimate_var_qxi
(estimate_var_artifacts), 86
estimate_var_qya
(estimate_var_artifacts), 86
estimate_var_qyi
(estimate_var_artifacts), 86
estimate_var_rho_int, 96
estimate_var_rho_int_bvdrr
(estimate_var_rho_int), 96
estimate_var_rho_int_bvirr
(estimate_var_rho_int), 96
estimate_var_rho_int_uvdrr
(estimate_var_rho_int), 96
estimate_var_rho_int_uvirr
(estimate_var_rho_int), 96
estimate_var_rho_tsa, 98
estimate_var_rho_tsa_bvdrr
(estimate_var_rho_tsa), 98
estimate_var_rho_tsa_bvirr
(estimate_var_rho_tsa), 98
estimate_var_rho_tsa_meas
(estimate_var_rho_tsa), 98
estimate_var_rho_tsa_rb1
(estimate_var_rho_tsa), 98
estimate_var_rho_tsa_rb2
(estimate_var_rho_tsa), 98
estimate_var_rho_tsa_uvdrr
(estimate_var_rho_tsa), 98
estimate_var_rho_tsa_uvirr
(estimate_var_rho_tsa), 98
estimate_var_rxaxa
(estimate_var_artifacts), 86
estimate_var_rxxi
(estimate_var_artifacts), 86
estimate_var_ryya
(estimate_var_artifacts), 86
estimate_var_ryyi
(estimate_var_artifacts), 86
estimate_var_tsa, 107
estimate_var_tsa_bvdrr
(estimate_var_tsa), 107
estimate_var_tsa_bvirr
(estimate_var_tsa), 107
estimate_var_tsa_meas
(estimate_var_tsa), 107
estimate_var_tsa_rb1
(estimate_var_tsa), 107
estimate_var_tsa_rb2
(estimate_var_tsa), 107
estimate_var_tsa_uvdrr
(estimate_var_tsa), 107
estimate_var_tsa_uvirr
(estimate_var_tsa), 107
estimate_var_ut
(estimate_var_artifacts), 86
estimate_var_ux
(estimate_var_artifacts), 86
filter_ma(), 111
filter_meta(filter_ma), 111
format_num, 112, 168

gamma function, 44, 45
generate_bib, 114, 168, 169, 172
generate_directory, 116
get_ad(get_stuff), 116
get_bootstrap(get_stuff), 116
generate_bib, 114, 168, 169, 172
get_cumulative(get_stuff), 116
get_escalc(get_stuff), 116
get_followup(get_stuff), 116
get_heterogeneity(get_stuff), 116
get_leave1out(get_stuff), 116
get_matrix(get_stuff), 116
get_metafor(get_stuff), 116
get_metatab(get_stuff), 116
get_plots(get_stuff), 116
get_stuff, 116

heterogeneity, 6, 122

knitr::is_html_output, 171
knitr::is_latex_output, 171

limits_tau, 125
limits_tau2, 126
lm_mat, 127
lm_matrix(lm_mat), 127

ma_d, 5, 6, 129, 135, 152, 172
ma_d_ad, 133
ma_d_ad(ma_d), 129
ma_d_barebones(ma_d), 129
ma_d_bb(ma_d), 129
ma_d_ic(ma_d), 129
ma_d_order2, 142
ma_generic, 144
ma_r, 5, 6, 42, 49, 58, 65, 76, 89, 134, 135, 145, 152, 172, 220
ma_r_ad, 56, 149
ma_r_ad(ma_r), 145
ma_r_barebones(ma_r), 145
ma_r_bb(ma_r), 145
ma_r_ic(ma_r), 145
ma_r_order2, 6, 163
matreg(lm_mat), 127

matrixreg(lm_mat), 127
merge_simdat_d, 165, 191
merge_simdat_r, 166, 198
metabulate, 6, 115, 166, 170, 172
metabulate_rmd_helper, 115, 169, 170
metareg, 6, 172
mix_dist, 173
mix_matrix, 175
mix_r_2group, 176

output_format, 115, 167

plot_cefp(plot_funnel), 178
plot_forest, 177
plot_funnel, 178
predict, 181
print, 181
psychmeta(psychmeta-package), 4
psychmeta-package, 4
psychmeta_news, 182

reattribute, 182
render, 115, 169
reshape_mat2dat, 5, 183
reshape_vec2mat, 184
reshape_wide2long, 5, 186

sensitivity, 6, 187
sensitivity_bootstrap(sensitivity), 187
sensitivity_cumulative(sensitivity), 187
sensitivity_leave1out(sensitivity), 187
simulate_alpha, 190
simulate_d_database, 6, 165, 191, 202
simulate_d_sample, 6, 194
simulate_matrix, 195
simulate_psych, 196
simulate_r_database, 6, 166, 198, 201, 203
simulate_r_sample, 6, 201
sparsify_simdat_d, 191, 202
sparsify_simdat_r, 198, 203
summary, 204

tibble, 169
tibble::print.tbl(), 181, 182
truncate_dist, 204
truncate_mean, 205
truncate_var, 206
unmix_matrix, 206
unmix_r_2group, 208

var_error_A, 209
var_error_alpha, 210
var_error_auc (var_error_A), 209
var_error_cles (var_error_A), 209
var_error_d, 211
var_error_delta, 212
var_error_g, 213
var_error_mult_R, 214
var_error_mult_Rsq (var_error_mult_R), 214
var_error_q, 215
var_error_R (var_error_mult_R), 214
var_error_r, 216
var_error_r_bvirr, 218
var_error_rel, 217
var_error_Rsq (var_error_mult_R), 214
var_error_u, 222

wt_cor (wt_cov), 223
wt_cov, 223
wt_dist, 224
wt_mean (wt_dist), 224
wt_var (wt_dist), 224