Package ‘robumeta’
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Depends grid
Description Functions for conducting robust variance estimation (RVE) meta-regression using both large and small sample RVE estimators under various weighting schemes. These methods are distribution free and provide valid point estimates, standard errors and hypothesis tests even when the degree and structure of dependence between effect sizes is unknown. Also included are functions for conducting sensitivity analyses under correlated effects weighting and producing RVE-based forest plots.
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### Data for Fitting Correlated Effects Model

**Description**
Fictional data used in Tanner-Tanner-Smith and Tipton (2013).

**Usage**
corrdat

**Format**
A dataframe containing 172 effect sizes from 39 studies used in Tanner-Smith and Tipton (2013).

**Source**
https://my.vanderbilt.edu/emilytannersmith/training-materials/

**References**

### Data for Fitting Correlated Effects Model With Small-Sample Corrections

**Description**
Data used in Tipton (2013).

**Usage**
corrdat.sm

**Format**
A dataframe containing 300 effect sizes from 28 studies used in Tipton (2013).

**Source**
Elizabeth Tipton
References


forest.robu

*Forest Plots for Robust Variance Estimation Meta-Analysis*

Description

`forest.robu` In meta-analysis, forest plots provide a graphical depiction of effect size estimates and their corresponding confidence intervals. The `forest.robu()` function in `robumeta` can be used to produce forest plots for RVE meta-analyses. The function requires the `grid` package and is based on examples provided in (Murrell, 2011). As is the case with traditional forest plots, point estimates of individual effect sizes are plotted as boxes with areas proportional to the weight assigned to that effect size. Importantly, here the weight is not necessarily proportional to the effect size variance or confidence intervals, since the combined study weight is divided evenly across the study effect sizes. Two-sided 95% confidence intervals are calculated for each effect size using a standard normal distribution and plotted along with each block. The overall effect is included at the bottom of the plot as a diamond with width equivalent to the confidence interval for the estimated effect. The RVE forest function is designed to provide users with forest plots which display each individual effect size used in the meta-analysis, while taking into account the study- or cluster-level properties inherent to the RVE analysis. As such, the user must specify columns from their original dataset that contain labels for the study or cluster and for the individual effect sizes.

Usage

```r
forest.robu(x, es.lab, study.lab, 
```

Arguments

- **x** An intercept-only RVE model previously fit using the `robu()` function.
- **study.lab** A vector of labels to be used to identify study (or cluster) level groupings in the forest plot. For instance, labels for the study column might be author names with corresponding publication years.
- **es.lab** A vector of labels to be used to individual effect sizes in the forest plot. Labels for individual effect sizes might be “Math Score” or “Reading Score” for a meta-analysis that included such measures or as simple as “Effect Size 1” and “Effect Size 2.”
- **...** Additional arguments to be passed to the forest function. Any number of additional columns can be specified to be plotted along side the confidence interval column and can be specified with the following syntax ```arg1'' = ``arg2'` where ```arg1''` is the title of the column on the forest plot, and ```arg2'` is the name of the column from the original data frame that contains the information to be displayed alongside the estimates and confidence intervals.
References


Examples

```r
# Load data
data(owald2013.ex1)

# Run intercept only model.
owald_intercept <- robu(formula = effect.size ~ 1, data = oswald2013.ex1,
                        studynum = Study, var.eff.size = var.eff.size,
                        rho = 0.8, small = TRUE)

# Create forest plot.
forest.robu(owald_intercept, es.lab = "Crit.Cat", study.lab = "Study",
            "Effect Size" = effect.size, # optional column
            "Weight" = r.weights) # optional column
```

---

**group.center**

Convenience function for calculating group-centered covariates.

Description

Creates a within-study (or within-cluster) version of the covariate in question.

Usage

```r
group.center(var, grp)
```

Arguments

- `var` The covariate to be group centered.
- `grp` A vector corresponding to the group identification.

Value

A column or vector containing the group.centered covariate.
Examples

```r
# Load data
data(corrdat)

# Create a group centered covariate
males_c <- group.center(corrdat$males, corrdat$studyid)
```

---

**group.mean**

*Convenience function for calculating group-mean covariates.*

### Description

Creates a between-study (or between-cluster) version of the covariate in question.

### Usage

```r
group.mean(var, grp)
```

### Arguments

- `var` The covariate containing the values to be group averaged.
- `grp` The group from which the average should be calculated.

### Value

A column or vector containing the group.mean covariate.

### Examples

```r
# Load data
data(corrdat)

# Create a group mean covariate
age_m <- group.mean(corrdat$age, corrdat$studynum)
```
hedgesdat

**Description**

Data from a meta-analysis on the effectiveness of phonics reading instruction by Ehri, Nunes, Stahl and Willows (2001). Data reported in Hedges, Tipton, and Johnson (2010) with example.

**Usage**

hedgesdat

**Format**

A dataframe containing 179 effect sizes from 66 different studies

**Source**

Hedges, Tipton, and Johnson (2010)

**References**


datat

**Description**

Data for Fitting Hierarchical Effects Model

**Usage**

hierdat

**Format**

A dataframe containing 68 effect sizes from 15 studies used in Tanner-Smith and Tipton (2013).

**Description**

Fictional data used in Tanner-Tanner-Smith and Tipton (2013).

**Usage**

hierdat

**Format**

A dataframe containing 68 effect sizes from 15 studies used in Tanner-Smith and Tipton (2013).
**Source**

https://my.vanderbilt.edu/emilytannersmith/training-materials/

**References**


<table>
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<tr>
<th>oswald2013</th>
<th><strong>IAT Criterion-Related Correlations</strong></th>
</tr>
</thead>
</table>

**Description**

Data from a meta-analysis on IAT conducted by Oswald et al., (2013) examining the predictive validity of the Implicit Association Test (IAT) and various explicit measures of bias for a variety of criterion measures of discrimination. Included in the dataset are the study level correlations between IAT scores and some criterion measure of discrimination.

**Usage**

oswald2013

**Format**

A dataframe containing 308 effect sizes from 46 studies.

<table>
<thead>
<tr>
<th>Study</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crit.Domain</td>
<td>Factor</td>
</tr>
<tr>
<td>IAT.ID</td>
<td>Integer</td>
</tr>
<tr>
<td>IAT.Focus</td>
<td>Factor</td>
</tr>
<tr>
<td>Crit.ID</td>
<td>Integer</td>
</tr>
<tr>
<td>Crit.Cat</td>
<td>Factor</td>
</tr>
<tr>
<td>Scoring</td>
<td>Factor</td>
</tr>
<tr>
<td>Target</td>
<td>Factor</td>
</tr>
<tr>
<td>Type</td>
<td>Factor</td>
</tr>
<tr>
<td>Sample.ID</td>
<td>Integer</td>
</tr>
<tr>
<td>N</td>
<td>Integer</td>
</tr>
<tr>
<td>R</td>
<td>Numeric</td>
</tr>
</tbody>
</table>

**Source**

References


IAT Criterion-Related Correlations

Description

Data from a meta-analysis on IAT conducted by Oswald et al., (2013) examining the predictive validity of the Implicit Association Test (IAT) and various explicit measures of bias for a variety of criterion measures of discrimination. Included in the dataset are the study-level correlations between IAT scores and criterion measures of neurological activity or response latency from the original oswald2013 dataset.

Usage

oswald2013.ex1

Format

A dataframe containing 32 effect sizes from 9 studies.

```
[,1] Study       Factor
[,2] Crit.Domain Factor
[,3] IAT.ID     Integer
[,4] IAT.Focus Factor
[,5] Crit.ID    Integer
[,6] Crit.Cat   Factor
[,7] Scoring    Factor
[,8] Target     Factor
[,9] Type       Factor
[,10] Sample.ID Integer
[,11] N         Integer
[,12] R         Numeric
[,13] effect.size Numeric
[,14] var.eff.size Numeric
```

Source

print.robu

References


print.robu Outputs Model Information

Description

Prints relevant information from robu function.

Usage

```r
## S3 method for class 'robu'
print(x, digits = 3, ...)
```

Arguments

- `x` Object from robu class.
- `digits` Controls the number of digits to print when printing numeric values.
- `...` Additional arguments to be passed to the fitting function.

References


Examples

```r
# Load data
data(hierdat)

### Small-Sample Corrections - Hierarchical Dependence Model
HierMod <- robu(formula = effectsize ~ binge + followup + sreport
                + age, data = hierdat, studynum = studyid,
                var.eff.size = var, modelweights = "HIER", small = FALSE)

print(HierMod) # Output results
```
Fitting Robust Variance Meta-Regression Models

Description

`robu` is used to meta-regression models using robust variance estimation (RVE) methods. `robu` can be used to estimate correlated and hierarchical effects models using the original (Hedges, Tipton and Johnson, 2010) and small-sample corrected (Tipton, 2013) RVE methods. In addition, `robu` contains options for fitting these models using user-specified weighting schemes (see the Appendix of Tipton (2013) for a discussion of non-efficient weights in RVE).

Usage

```r
calling robu(formula, data, studynum, var.eff.size, userweights, modelweights =
          c("CORR", "HIER"), rho = 0.8, small = TRUE,...)
```

Arguments

- **formula**: An object of class "formula". A typical meta-regression formula will look similar to `y ~ x1 + x2...`, where `y` is a vector of effect sizes and `x1 + x2...` are (optional) user-specified covariates. An intercept only model can be specified with `y ~ 1` and the intercept can be omitted as follows `y ~ -1 +...`

- **data**: A data frame, list or environment or an object coercible by as.data.frame to a data frame.

- **studynum**: A vector of study numbers to be used in model fitting. `studynum` must be a numeric or factor variable that uniquely identifies each study.

- **var.eff.size**: A vector of user-calculated effect-size variances.

- **rho**: User-specified within-study effect-size correlation used to fit correlated (`modelweights = "CORR"`) effects meta-regression models. The value of `rho` must be between 0 and 1. The default value for `rho` is 0.8. `rho` is not specified for hierarchical (`modelweights = "HIER"`) effects models.

- **modelweights**: User-specified model weighting scheme. The two available options are `modelweights = "CORR"` and `modelweights = "HIER"`. The default is "CORR". See Hedges, Tipton and Johnson (2010) and Tipton (2013) for extended explanations of each weighting scheme.

- **userweights**: A vector of user-specified weights if non-efficient weights are of interest. Users interested in non-efficient weights should see the Appendix of Tipton (2013) for a discussion of the role of non-efficient weights in RVE).

- **small**: `small = TRUE` is used to fit the meta-regression models with the small-sample corrections for both the residuals and degrees of freedom, as detailed in Tipton (2013). Users wishing to use the original RVE estimator must specify `small = FALSE` as the corrected estimator is the default option.

- **...**: Additional arguments to be passed to the fitting function.
Value

output A data frame containing some combination of the robust coefficient names and values, standard errors, t-test value, confidence intervals, degrees of freedom and statistical significance.

n The number of studies in the sample n

k The number of effect sizes in the sample k

k descriptives the minimum min.k, mean mean.k, median median.k, and maximum max.k number of effect sizes per study.

tau.sq. tau.sq is the between study variance component in the correlated effects meta-regression model and the between-cluster variance component in the hierarchical effects model. tau.sq is calculated using the method-of-moments estimator provided in Hedges, Tipton, and Johnson (2010). For the correlated effects model the method-of-moments estimator depends on the user-specified value of rho.

omega.sq. omega.sq is the between-studies-within-cluster variance component for the hierarchical effects meta-regression model. omega.sq is calculated using the method-of-moments estimator provided in Hedges, Tipton, and Johnson (2010) erratum.

I.2 I.2 is a test statistics used to quantify the amount of variability in effect size estimates due to effect size heterogeneity as opposed to random variation.

References


Examples

# Load data
data(hierdat)

# Small-Sample Corrections - Hierarchical Dependence Model
HierModSm <- robu(formula = effectsize ~ binge + followup + sreport + age, data = hierdat, studynum = studyid, var.eff.size = var, modelweights = "HIER", small = TRUE)

print(HierModSm) # Output results
Description

sensitivity is used to assess the impact of differing rho values on the correlated effects meta-regression model.

Usage

sensitivity(x)

Arguments

x A dataframe containing values of rho, tau squared, coefficient estimates, and standard errors.

References


Examples

# Correlated Effects Model
CorrMod <- robu(formula = effectsize ~ followup + males + binge + college, 
data = corrdat, studynum = studyid, var.eff.size = var, 
rho = .8, modelweights = "CORR", small = FALSE)

sensitivity(CorrMod) # Output sensitivity
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