Package 'MAIVE'

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Type Package

Title Meta Analysis Instrumental Variable Estimator

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URL https://meta-analysis.cz/maive/,
https://github.com/meta-analysis-es/maive

BugReports https://github.com/meta-analysis-es/maive/issues

Description Meta-analysis traditionally assigns more weight to studies with lower standard errors, assuming higher precision. However, in observational research, precision must be estimated and is vulnerable to manipulation, such as p-hacking, to achieve statistical significance. This can lead to spurious precision, invalidating inverse-variance weighting and bias-correction methods like funnel plots. Common methods for addressing publication bias, including selection models, often fail or exacerbate the problem. This package introduces an instrumental variable approach to limit bias caused by spurious precision in meta-analysis. Methods are described in 'Irsova et al.' (2025) <doi:10.1038/s41467-025-63261-0>.

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Depends R (>= 4.0.0)

Imports stats, cli, clubSandwich

Suggests testthat, knitr, rmarkdown, varhandle

VignetteBuilder knitr

NeedsCompilation no

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Contents

`get_funnel_plot` *Draw a funnel plot (base graphics)*

Description

High-level wrapper that accepts the original input data and the result returned by ‘maive()‘ / ‘waive()‘, prepares the necessary vectors/metadata, and draws the funnel plot on the currently active graphics device.

Usage

```
get_funnel_plot(dat, result, instrument = NULL, model_type = "MAIVE")
```

Arguments

`dat`	Data frame containing at least numeric columns ‘bs‘ (effect sizes) and ‘sebs‘ (standard errors).
`result`	Result list returned by ‘maive()‘ or ‘waive()‘.
`instrument`	Optional indicator (0/1). If ‘NULL‘, inferred from ‘result‘.
`model_type`	Label used for plot text/legend (e.g., ‘"MAIVE"‘ or ‘"WAIVE"‘).

Details

Device management (PNG/SVG/PDF, resolution, base64 encoding) is intentionally left to the caller.

Value

Invisibly returns ‘NULL‘.

`maive` *R code for MAIVE*

Description

R package for MAIVE: "Spurious Precision in Meta-Analysis of Observational Research" by Zuzana Irsova, Pedro Bom, Tomas Havranek, Petr Cala, and Heiko Rachinger.

Usage

```
maive(
  dat,
  method,
  weight,
  instrument,
  studylevel,
  SE,
  AR,
  first_stage = 0L,
  estimate = NULL,
  se = NULL,
  n = NULL,
  study_id = NULL,
  seed = 123
)
```

Arguments

`dat`	Data frame with columns bs, sebs, Ns, study_id (optional).
`method`	1 FAT-PET, 2 PEESE, 3 PET-PEESE, 4 EK.
`weight`	0 no weights, 1 standard weights, 2 MAIVE adjusted weights, 3 study weights.
`instrument`	1 yes, 0 no.
`studylevel`	Correlation at study level: 0 none, 1 fixed effects, 2 cluster.
`SE`	SE estimator: 0 CR0 (Huber-White), 1 CR1 (Standard empirical correction), 2 CR2 (Bias-reduced estimator), 3 wild bootstrap.
`AR`	Anderson Rubin corrected CI for weak instruments (available for unweighted and MAIVE-adjusted weight versions of PET, PEESE, PET-PEESE, not available for fixed effects): 0 no, 1 yes.
`first_stage`	First-stage specification for the variance model: 0 levels, 1 log.
`estimate`	Optional column name to use instead of 'bs'
`se`	Optional column name to use instead of 'sebs'
`n`	Optional column name to use instead of 'Ns'
`study_id`	Optional column name for study identifiers
`seed`	Seed for the wild bootstrap when SE = 3. Use NULL to avoid setting a seed (results depend on the current RNG state). Default is 123 for historical reproducibility.

Details

Guided, interactive workflow available at https://www.easymeta.org.

Data `dat` can be imported from an Excel file via: `dat <- read_excel("inputdata.xlsx")` or from a csv file via: `dat <- read.csv("inputdata.csv")` It should contain:

- Estimates: bs
- Standard errors: sebs
- Number of observations: Ns
- Optional: study_id

Default option for MAIVE: MAIVE-PET-PEESE, unweighted, instrumented, cluster SE, wild bootstrap, AR.

Value

- beta: MAIVE meta-estimate
- SE: MAIVE standard error
- F-test: heteroskedastic robust F-test of the first step instrumented SEs
- beta_standard: point estimate from the method chosen
- SE_standard: standard error from the method chosen
- Hausman: Hausman type test: comparison between MAIVE and standard version
- Chi2: 5
- SE_instrumented: instrumented standard errors
- AR_CI: Anderson-Rubin confidence interval for weak instruments
- pub bias p-value: p-value of test for publication bias / p-hacking based on instrumented FAT
- egger_coef: Egger Coefficient (PET estimate)
- egger_se: Egger Standard Error (PET standard error)
- egger_boot_ci: Confidence interval for the Egger coefficient using the selected resampling scheme
- egger_ar_ci: Anderson-Rubin confidence interval for the Egger coefficient (when available)
- is_quadratic_fit: Details on quadratic selection and slope behaviour
- boot_result: Boot result
- slope_coef: Slope coefficient
- petpeese_selected: Which model (PET or PEESE) was selected when method=3 (NA otherwise)
- peese_se2_coef: Coefficient on SE^2 when PEESE is the final model (NA otherwise)
- peese_se2_se: Standard error of the PEESE SE^2 coefficient (NA otherwise)

Examples

```
dat <- data.frame(
  bs = c(0.5, 0.45, 0.55, 0.6),
  sebs = c(0.25, 0.2, 0.22, 0.27),
  Ns = c(50, 80, 65, 90)
)

result <- maive(dat,
  method = 3, weight = 0, instrument = 1,
  studylevel = 0, SE = 0, AR = 0, first_stage = 0
)
```

`waive` *WAIVE: More Aggressive Correction for P-Hacking and Spurious Precision*

Description

WAIVE (Weighted Adjusted Instrumental Variable Estimator) provides a more aggressive correction for p-hacking and spurious precision by extending MAIVE with exponential-decay weights that downweight both spuriously precise estimates and extreme outliers.

Usage

```
waive(
  dat,
  method,
  weight,
  instrument,
  studylevel,
  SE,
  AR,
  first_stage = 0L,
  estimate = NULL,
  se = NULL,
  n = NULL,
  study_id = NULL,
  seed = 123
)
```

Arguments

`dat`	Data frame with columns bs, sebs, Ns, study_id (optional).
`method`	1 FAT-PET, 2 PEESE, 3 PET-PEESE, 4 EK.
`weight`	0 no weights, 1 standard weights, 2 MAIVE adjusted weights, 3 study weights.
`instrument`	1 yes, 0 no.

studylevel	Correlation at study level: 0 none, 1 fixed effects, 2 cluster.
SE	SE estimator: 0 CR0 (Huber-White), 1 CR1 (Standard empirical correction), 2 CR2 (Bias-reduced estimator), 3 wild bootstrap.
AR	Anderson Rubin corrected CI for weak instruments (available for unweighted and MAIVE-adjusted weight versions of PET, PEESE, PET-PEESE, not available for fixed effects): 0 no, 1 yes.
first_stage	First-stage specification for the variance model: 0 levels, 1 log.
estimate	Optional column name to use instead of 'bs'
se	Optional column name to use instead of 'sebs'
n	Optional column name to use instead of 'Ns'
study_id	Optional column name for study identifiers
seed	Seed for the wild bootstrap when SE = 3. Use NULL to avoid setting a seed (results depend on the current RNG state). Default is 123 for historical reproducibility.

Details

Guided, interactive workflow available at https://www.easymeta.org.

For technical details on WAIVE methodology, see: https://meta-analysis.cz/waive_ottawa.pdf

WAIVE combines variance instrumentation (as in MAIVE) with robust downweighting based on first-stage residuals. Studies with negative residuals (spurious precision) or extreme residuals (outliers) receive exponentially reduced influence in the meta-analytic estimate. This makes WAIVE more aggressive than standard MAIVE at correcting for p-hacking and handling outliers.

Value

List with the same structure as `maive()`. See `?maive` for details.

Examples

```
dat <- data.frame(
  bs = c(0.5, 0.45, 0.55, 0.6),
  sebs = c(0.25, 0.2, 0.22, 0.27),
  Ns = c(50, 80, 65, 90)
)

result <- waive(dat,
  method = 3, weight = 0, instrument = 1,
  studylevel = 0, SE = 0, AR = 0, first_stage = 0
)
```

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