Package 'messi'

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Type Package

Title Mediation with External Summary Statistic Information

Version 0.1.2

Description Fits the MESSI, hard constraint, and unconstrained models in Boss et al. (2023) <doi:10.48550/arXiv.2306.17347> for mediation analyses with external summary-level information on the total effect.

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Encoding UTF-8

LazyData true

Biarch true

Depends R (>= 3.6.2)

Imports MASS, ggplot2, patchwork, progress

URL https://github.com/umich-cphds/messi

BugReports https://github.com/umich-cphds/messi/issues

RoxygenNote 7.3.2

NeedsCompilation no

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Repository CRAN

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Contents

`constrained.unpenalized` *Estimate hard constraint model parameters using cyclical coordinate descent.*

Description

Estimate hard constraint model parameters using cyclical coordinate descent.

Usage

```
constrained.unpenalized(
  Y,
  M,
  A,
  C = NULL,
  T.hat.external,
  err.tol.out = 1e-08,
  err.tol.med = 1e-08,
  max.itr = 10000
)
```

Arguments

`Y`	A (n x 1) continuous outcome vector.
`M`	A (n x p_m) matrix of mediators.
`A`	A (n x 1) vector of exposures.
`C`	A (n x p_c) matrix of confounders and adjustment covariates. If there are no confounders or adjustment covariates set C = NULL.
`T.hat.external`	External estimate of the total effect.
`err.tol.out`	Termination condition for cyclical coordinate descent algorithm with respect to the outcome model parameters.
`err.tol.med`	Termination condition for cyclical coordinate descent algorithm with respect to the mediator model parameters.
`max.itr`	Maximum number of iterations for cyclical coordinate descent algorithm.

Value

A list containing point estimates of the hard constraint model parameters and an indicator of whether the algorithm converges.

Med — *Simulated data with real mediation effect*

Description

Simulated data with real mediation effect

Usage

```
Med
```

Format

An object of class `list` of length 8.

Examples

```
data(Med)
```

messi — *Implementation of Mediation with External Summary Statistic Information (MESSI) from Boss et al. (2024).*

Description

Implementation of Mediation with External Summary Statistic Information (MESSI) from Boss et al. (2024).

Usage

```
messi(
  Y,
  M,
  A,
  C = NULL,
  method = "MESSI EB",
  T.hat.external,
  var.T.hat.external,
  n.boot = 200,
  s2.fixed = NULL
)
```

Arguments

Y	A (n x 1) continuous outcome vector.
M	A (n x p_m) matrix of mediators.
A	A (n x 1) vector of exposures.
C	A (n x p_c) matrix of confounders and adjustment covariates. If there are no confounders or adjustment covariates set C = NULL.
method	A string specifying which method to use. Options include 'Unconstrained', 'Hard', 'MESSI EB', and 'MESSI Fixed'. Default is 'MESSI EB'.
T.hat.external	External estimate of the total effect. Set to NULL if method = 'Unconstrained'.
var.T.hat.external	Estimated variance of the external estimator of the total effect. Set to NULL if method = 'Unconstrained' or method = 'Hard'.
n.boot	Number of parametric bootstrap draws for obtaining quantile-based confidence intervals for the TE and NDE. Relevant for method = 'MESSI EB' and method = 'MESSI Fixed'. Can set to NULL for method = 'Unconstrained' and method = 'Hard'.
s2.fixed	Option to specify the tuning parameter s^2 in the MESSI model. Only use if method = 'MESSI Fixed'.

Details

The MESSI EB method should be the default method if the user is not sure which method to use.

Value

A list containing the (1) point estimates and confidence intervals for the natural direct effect, the natural indirect effect, and the total effect (2) point estimates for all mediation model parameters (3) the asymptotic variance covariance matrix corresponding to alpha_a and beta_m.

Examples

```
data(Med)

Y = Med$Y
M = Med$M
A = Med$A
C = Med$C
T.hat.external = Med$T.hat.external
var.T.hat.external = Med$var.T.hat.external

test <- messi(Y = Y, M = M, A = A, C = C, method = 'Unconstrained', T.hat.external = T.hat.external,
              var.T.hat.external = var.T.hat.external, s2.fixed = NULL)

n = Med$n
p = Med$p

plot_messi(n = n, alpha.a.hat = test$alpha.a.hat, beta.m.hat = test$beta.m.hat,
           labels = paste0("M",1:p), asym.var.mat = test$asym.var.mat)
```

```
test <- messi(Y = Y, M = M, A = A, C = C, method = 'Hard', T.hat.external = T.hat.external,
              var.T.hat.external = var.T.hat.external, s2.fixed = NULL)
```

`nullMed` *Simulated data with null mediation effect*

Description

Simulated data with null mediation effect

Usage

```
nullMed
```

Format

An object of class `list` of length 4.

Examples

```
data(nullMed)
```

`plot_messi` *Forestplot to Summarize Estimation and Inference on alpha_a and beta_m.*

Description

Forestplot to Summarize Estimation and Inference on alpha_a and beta_m.

Usage

```
plot_messi(n, alpha.a.hat, beta.m.hat, labels, asym.var.mat)
```

Arguments

`n`	Sample size of the analysis
`alpha.a.hat`	Estimate of alpha_a, a (p_m x 1) vector.
`beta.m.hat`	Estimate of beta_m, a (p_m x 1) vector.
`labels`	A (p_m x 1) vector of mediator names. Make sure that the labels are in the same order as the mediators appear in the design matrix.
`asym.var.mat`	Joint asymptotic variance-covariance matrix of alpha_a and beta_m, a (2p_m x 2p_m) matrix.

Value

Data frames and forestplots summarizing alpha_a and beta_m estimation.

Examples

```
data(Med)

Y = Med$Y
M = Med$M
A = Med$A
C = Med$C
T.hat.external = Med$T.hat.external
var.T.hat.external = Med$var.T.hat.external

test <- messi(Y = Y, M = M, A = A, C = C, method = 'Unconstrained', T.hat.external = T.hat.external,
              var.T.hat.external = var.T.hat.external, s2.fixed = NULL)

n = Med$n
p = Med$p

plot_messi(n = n, alpha.a.hat = test$alpha.a.hat, beta.m.hat = test$beta.m.hat,
           labels = paste0("M",1:p), asym.var.mat = test$asym.var.mat)
```

---

rand.eff.coord.desc.unpenalized

Cyclical coordinate descent algorithm for the M-step in the EM Algorithm for the maximizing the soft constraint model likelihood.

Description

Cyclical coordinate descent algorithm for the M-step in the EM Algorithm for the maximizing the soft constraint model likelihood.

Usage

```
rand.eff.coord.desc.unpenalized(
  Y,
  M,
  A,
  C = NULL,
  first.moment,
  second.moment,
  err.tol.out = 1e-08,
  err.tol.med = 1e-08,
  max.itr = 10000
)
```

Arguments

Y	A (n x 1) continuous outcome vector.
M	A (n x p_m) matrix of mediators.
A	A (n x 1) vector of exposures.
C	A (n x p_c) matrix of confounders and adjustment covariates. If there are no confounders or adjustment covariates set C = NULL.
first.moment	Posterior expectation of the total effect parameter.
second.moment	Posterior expection of the squared total effect parameter.
err.tol.out	Termination condition for cyclical coordinate descent algorithm with respect to the outcome model parameters.
err.tol.med	Termination condition for cyclical coordinate descent algorithm with respect to the mediator model parameters.
max.itr	Maximum number of iterations for cyclical coordinate descent algorithm.

Value

A list containing point estimates of the soft constraint model parameters and an indicator of whether the algorithm converges.

---

rand.eff.unpenalized *Estimate soft constraint model parameters using the EM algorithm.*

Description

Estimate soft constraint model parameters using the EM algorithm.

Usage

```
rand.eff.unpenalized(
  Y,
  M,
  A,
  C = NULL,
  rand.eff.mean,
  rand.eff.var,
  T.hat.external = T.hat.external,
  var.T.hat.external = var.T.hat.external,
  err.tol.out = 1e-08,
  err.tol.med = 1e-08,
  max.itr = 10000
)
```

Arguments

Y	A (n x 1) continuous outcome vector.
M	A (n x p_m) matrix of mediators.
A	A (n x 1) vector of exposures.
C	A (n x p_c) matrix of confounders and adjustment covariates. If there are no confounders or adjustment covariates set C = NULL.
rand.eff.mean	Mean of the random effects distribution for the internal total effect parameter.
rand.eff.var	Variance of the random effects distribution for the internal total effect parameter.
T.hat.external	External estimate of the total effect.
var.T.hat.external	Estimated variance of the external total effect estimator.
err.tol.out	Termination condition for cyclical coordinate descent algorithm with respect to the outcome model parameters.
err.tol.med	Termination condition for cyclical coordinate descent algorithm with respect to the mediator model parameters.
max.itr	Maximum number of iterations for cyclical coordinate descent algorithm.

Value

A list containing point estimates of the soft constraint model parameters and an indicator of whether the algorithm converges.

---

unconstrained.unpenalized

Estimate unconstrained model parameters.

Description

Estimate unconstrained model parameters.

Usage

```
unconstrained.unpenalized(Y, M, A, C = NULL)
```

Arguments

Y	A (n x 1) continuous outcome vector.
M	A (n x p_m) matrix of mediators.
A	A (n x 1) vector of exposures.
C	A (n x p_c) matrix of confounders and adjustment covariates. If there are no confounders or adjustment covariates set C = NULL.

Value

A list containing point estimates of the unconstrained model parameters.

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