Package 'repmix'

September 10, 2025

Version 0.2

Date 2025-09-10

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Title Analysis of Replication Studies using Mixture Priors

Description Provides functionality for Bayesian analysis of replication studies using mixture prior approaches as propsed in Macrì Demartino et al. (2024) <doi:10.48550/arXiv.2406.19152>.

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Encoding UTF-8

Suggests roxygen2, tinytest

NeedsCompilation no

RoxygenNote 7.3.2

URL https://github.com/RoMaD-96/repmix

BugReports https://github.com/RoMaD-96/repmix/issues

Contents

`marglik` *Marginal likelihood of of the replication effect estimate*

Description

This function computes the marginal likelihood of the replication data under a mixture prior that incorporates the original data. See the details section for details regarding data model and prior distributions.

Usage

```
marglik(tr, sr, to, so, w = NULL, x = 1, y = 1, m = 0, v = 1)
```

Arguments

`tr`	Effect estimate from the replication study.
`sr`	Standard error of the replication effect estimate.
`to`	Effect estimate from the original study.
`so`	Standard error of the original effect estimate.
`w`	Fixed weight parameter. Is only taken into account when not `NULL`. Defaults to `NULL`.
`x`	Number of successes parameter of the beta prior for `w`. Only taken into account when `w` is `NULL`. Defaults to `1`.
`y`	Number of failures parameter of the beta prior for `w`. Only taken into account when `w` is `NULL`. Defaults to `1`.
`m`	Mean parameter of the normal prior component. Defaults to `0`.
`v`	Variance parameter of the normal prior component. Defaults to `1`.

Details

A normal likelihood around the underlying effect size θ is assumed for the effect estimate from the replication study

$$\texttt{tr} \mid \theta \sim \mathrm{N}(\theta, \texttt{sr}^2)$$

A mixture prior is assumed for the effect size θ with one component being a normal distribution with mean equal to the original effect estimate `to`, variance equal to the squared original standard error `so^2`, and mixture weight `w`, and the other component being a normal distribution with mean `m`, variance `v`, and mixture weight $1 - \texttt{w}$

$$\theta \mid w \sim \texttt{w} \times \mathrm{N}(\texttt{to}, \texttt{so}^2) + (1 - \texttt{w}) \times \mathrm{N}(\texttt{m}, \texttt{v})$$

The mixture weight `w` can either be fixed to a value between zero and one, or a Beta prior can be assumed for it

$$w \sim \mathrm{Beta}(x, y)$$

Value

The marginal likelihood of the replication effect estimate.

Author(s)

Samuel Pawel, Roberto Macri Demmartino

Examples

```
## uniform prior specified for weight w
marglik(tr = 0.09, sr = 0.05, to = 0.21, so = 0.05, x = 1, y = 1, m = 0, v = 4)
marglik(tr = 0.21, sr = 0.06, to = 0.21, so = 0.05, x = 1, y = 1, m = 0, v = 4)
marglik(tr = 0.44, sr = 0.04, to = 0.21, so = 0.05, x = 1, y = 1, m = 0, v = 4)

## fixed weight w = 0.5
marglik(tr = 0.09, sr = 0.05, to = 0.21, so = 0.05, w = 0.2, m = 0, v = 4)
marglik(tr = 0.21, sr = 0.06, to = 0.21, so = 0.05, w = 0.2, m = 0, v = 4)
marglik(tr = 0.44, sr = 0.04, to = 0.21, so = 0.05, w = 0.2, m = 0, v = 4)
```

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posteriormix *Joint posterior density of effect size and weight parameter*

Description

This function computes the posterior density of effect size and weight parameter based on the data from original and replication study using a mixture prior to incorporate the original data into the analysis of the replication data. See the details section for details regarding data model and prior distributions.

Usage

```
posteriormix(theta, w, tr, sr, to, so, x = 1, y = 1, m = 0, v = 1)
```

Arguments

theta	Effect size. Has to be of length one or the same length as w.
w	Weight parameter. Has to be of length one or the same length as theta.
tr	Effect estimate from the replication study.
sr	Standard error of the replication effect estimate.
to	Effect estimate from the original study.
so	Standard error of the original effect estimate.
x	Number of successes parameter of the beta prior for w. Defaults to 1.
y	Number of failures parameter of the beta prior for w. Defaults to 1.
m	Mean parameter of the normal prior component. Defaults to 0.
v	Variance parameter of the normal prior component. Defaults to 1.

Details

A normal likelihood around the underlying effect size θ is assumed for the effect estimate from the replication study

$$\texttt{tr} \mid \theta \sim \text{N}(\theta, \texttt{sr}^2)$$

A mixture prior is assumed for the effect size θ with one component being a normal distribution with mean equal to the original effect estimate `to`, variance equal to the squared original standard error `so^2`, and mixture weight w, and the other component being a normal distribution with mean `m`, variance `v`, and mixture weight $1 - w$

$$\theta \mid w \sim w \times \text{N}(\texttt{to}, \texttt{so}^2) + (1 - w) \times \text{N}(\texttt{m}, \texttt{v})$$

A Beta prior is assumed for the weight parameter

$$w \sim \text{Beta}(x, y)$$

Value

The joint posterior density for a pair of effect size and weight parameter.

Author(s)

Samuel Pawel, Roberto Macri Demmartino

Examples

```
## 2D plot of posterior density
w <- seq(0, 1, length.out = 200)
theta <- seq(0, 0.3, length.out = 200)
parGrid <- expand.grid(w = w, theta = theta)
postdens <- posteriormix(theta = parGrid$theta, w = parGrid$w, tr = 0.09,
                         sr = 0.05, to = 0.2, so = 0.05, m = 0, v = 4)
postdensMat <- matrix(data = postdens, ncol = 200, byrow = TRUE)
filled.contour(x = theta, y = w, z = postdensMat,
               xlab = bquote("Effect size" ~ theta),
               ylab = "Weight parameter w", nlevels = 15,
           color.palette = function(n) hcl.colors(n = n, palette = "Blues 3", rev = TRUE))
```

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thetaHPD *Highest posterior density interval for effect size*

Description

This function computes the highest posterior density interval for the effect size based on the data from original and replication study using a mixture prior to incorporate the original data into the analysis of the replication data. See the details section for details regarding data model and prior distributions.

Usage

```
thetaHPD(level = 0.95, tr, sr, to, so, w = NULL, x = 1, y = 1, m = 0, v = 1)
```

Arguments

level	Credibility level. Defaults to 0.95.
tr	Effect estimate from the replication study.
sr	Standard error of the replication effect estimate.
to	Effect estimate from the original study.
so	Standard error of the original effect estimate.
w	Fixed weight parameter. Is only taken into account when not NULL. Defaults to NULL.
x	Number of successes parameter of the beta prior for w. Only taken into account when w is NULL. Defaults to 1.
y	Number of failures parameter of the beta prior for w. Only taken into account when w is NULL. Defaults to 1.
m	Mean parameter of the normal prior component. Defaults to 0.
v	Variance parameter of the normal prior component. Defaults to 1.

Details

A normal likelihood around the underlying effect size θ is assumed for the effect estimate from the replication study

$$\mathtt{tr} \mid \theta \sim \mathrm{N}(\theta, \mathtt{sr}^2)$$

A mixture prior is assumed for the effect size θ with one component being a normal distribution with mean equal to the original effect estimate to, variance equal to the squared original standard error so^2, and mixture weight w, and the other component being a normal distribution with mean m, variance v, and mixture weight $1 - w$

$$\theta \mid w \sim w \times \mathrm{N}(\mathtt{to}, \mathtt{so}^2) + (1 - w) \times \mathrm{N}(\mathtt{m}, \mathtt{v})$$

The weight parameter can either be fixed to a specified value or a Beta prior can assumed for it

$$w \sim \mathrm{Beta}(x, y)$$

Value

The highest posterior density interval at the specified credibility level and posterior median for the effect size.

Author(s)

Samuel Pawel, Roberto Macri Demmartino

Examples

```
## tipping point analysis (computing HPDs for range of weights from 0 to 1)
to <- 0.21
tr <- 0.09
so <- 0.05
sr <- 0.045
w <- seq(0, 1, length.out = 20)
HPDs <- t(sapply(X = w, FUN = function(w) {
               thetaHPD(level = 0.95, tr = tr, sr = sr, to = to,
                        so = so, w = w, m = 0, v = 4)
}))
plot(NA, NA, type = "n", ylim = c(0, 0.3), xlim = c(-0.25, 1.25),
     xlab = "Weight of original study",
     ylab = "Posterior median with 95% HPDI", las = 1)
arrows(x0 = w, y0 = HPDs[,1], y1 = HPDs[,3], code = 3, angle = 90, length = 0.05,
       col = 4)
points(x = w, y = HPDs[,2], pch = 20, col = 4)
arrows(x0 = c(-0.2, 1.2), y0 = c(tr - 1.96*sr, to - 1.96*so),
       y1 = c(tr + 1.96*sr, to + 1.96*so), code = 3, angle = 90, length = 0.05,
       col = c(1, 2))
points(x = c(-0.2, 1.2), y = c(tr, to), pch = 20, col = c(1, 2))
axis(side = 1, at = c(-0.2, 1.2), labels = c("Replication", "Original"))
```

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thetaposteriormix *Marginal posterior density of effect size*

Description

This function computes the marginal posterior density of the effect size based on the data from original and replication study using a mixture prior to incorporate the original data into the analysis of the replication data. See the details section for details regarding data model and prior distributions.

Usage

```
thetaposteriormix(theta, tr, sr, to, so, w = NULL, x = 1, y = 1, m = 0, v = 1)
```

Arguments

theta	Effect size.
tr	Effect estimate from the replication study.
sr	Standard error of the replication effect estimate.
to	Effect estimate from the original study.
so	Standard error of the original effect estimate.
w	Fixed weight parameter. Is only taken into account when not NULL. Defaults to NULL.

x	Number of successes parameter of the beta prior for w. Only taken into account when w is NULL. Defaults to 1.
y	Number of failures parameter of the beta prior for w. Only taken into account when w is NULL. Defaults to 1.
m	Mean parameter of the normal prior component. Defaults to 0.
v	Variance parameter of the normal prior component. Defaults to 1.

Details

A normal likelihood around the underlying effect size θ is assumed for the effect estimate from the replication study

$$\mathtt{tr} \mid \theta \sim \mathrm{N}(\theta, \mathtt{sr}^2)$$

A mixture prior is assumed for the effect size θ with one component being a normal distribution with mean equal to the original effect estimate to, variance equal to the squared original standard error so^2, and mixture weight w, and the other component being a normal distribution with mean m, variance v, and mixture weight $1 - w$

$$\theta \mid w \sim w \times \mathrm{N}(\mathtt{to}, \mathtt{so}^2) + (1 - w) \times \mathrm{N}(\mathtt{m}, \mathtt{v})$$

The weight parameter can either be fixed to a specified value or a Beta prior can assumed for it

$$w \sim \mathrm{Beta}(x, y)$$

Value

The marginal posterior density for the effect size.

Author(s)

Samuel Pawel, Roberto Macri Demmartino

Examples

```
theta <- seq(0, 0.3, length.out = 100)
post <- thetaposteriormix(theta = theta, tr = 0.09, sr = 0.05, to = 0.21, so = 0.05,
                          x = 1, y = 1, m = 0, v = 4)
plot(theta, post, type = "l", xlab = bquote("Effect size" ~ theta),
     ylab = "Marginal posterior density", las = 1)
```

wHPD *Highest posterior density interval for the mixture weight*

Description

This function computes the highest posterior density interval for the mixture weight based on the data from original and replication study using a mixture prior to incorporate the original data into the analysis of the replication data. See the details section for details regarding data model and prior distributions.

Usage

```
wHPD(level = 0.95, tr, sr, to, so, x = 1, y = 1, m = 0, v = 1)
```

Arguments

level	Credibility level. Defaults to 0.95.
tr	Effect estimate from the replication study.
sr	Standard error of the replication effect estimate.
to	Effect estimate from the original study.
so	Standard error of the original effect estimate.
x	Number of successes parameter of the beta prior for w. Defaults to 1.
y	Number of failures parameter of the beta prior for w. Defaults to 1.
m	Mean parameter of the normal prior component. Defaults to 0.
v	Variance parameter of the normal prior component. Defaults to 1.

Details

A normal likelihood around the underlying effect size θ is assumed for the effect estimate from the replication study

$$\texttt{tr} \mid \theta \sim \text{N}(\theta, \texttt{sr}^2)$$

A mixture prior is assumed for the effect size θ with one component being a normal distribution with mean equal to the original effect estimate to, variance equal to the squared original standard error so^2, and mixture weight w, and the other component being a normal distribution with mean m, variance v, and mixture weight $1 - w$

$$\theta \mid w \sim w \times \text{N}(\texttt{to}, \texttt{so}^2) + (1 - w) \times \text{N}(\texttt{m}, \texttt{v})$$

A Beta prior is assumed for the weight parameter

$$w \sim \text{Beta}(x, y)$$

Value

The highest posterior density interval at the specified credibility level and posterior median for the mixture weight.

Author(s)

Samuel Pawel, Roberto Macri Demmartino

Examples

```
wHPD(level = 0.95, tr = 0.09, sr = 0.05, to = 0.21, so = 0.05, x = 1, y = 1,
      m = 0, v = 4)
wHPD(level = 0.95, tr = 0.21, sr = 0.06, to = 0.21, so = 0.05, x = 1, y = 1,
      m = 0, v = 4)
wHPD(level = 0.95, tr = 0.44, sr = 0.04, to = 0.21, so = 0.05, x = 1, y = 1,
      m = 0, v = 4)
```

---

wposteriormix *Marginal posterior density of mixture weight*

Description

This function computes the marginal posterior density of the mixture weight based on the data from original and replication study using a mixture prior to incorporate the original data into the analysis of the replication data. See the details section for details regarding data model and prior distributions.

Usage

```
wposteriormix(w, tr, sr, to, so, x = 1, y = 1, m = 0, v = 1)
```

Arguments

w	Weight parameter.
tr	Effect estimate from the replication study.
sr	Standard error of the replication effect estimate.
to	Effect estimate from the original study.
so	Standard error of the original effect estimate.
x	Number of successes parameter of the beta prior for w. Defaults to 1.
y	Number of failures parameter of the beta prior for w. Defaults to 1.
m	Mean parameter of the normal prior component. Defaults to 0.
v	Variance parameter of the normal prior component. Defaults to 1.

Details

A normal likelihood around the underlying effect size θ is assumed for the effect estimate from the replication study

$$\texttt{tr} \mid \theta \sim \text{N}(\theta, \texttt{sr}^2)$$

A mixture prior is assumed for the effect size θ with one component being a normal distribution with mean equal to the original effect estimate `to`, variance equal to the squared original standard error `so^2`, and mixture weight w, and the other component being a normal distribution with mean `m`, variance `v`, and mixture weight $1 - w$

$$\theta \mid w \sim w \times \text{N}(\texttt{to}, \texttt{so}^2) + (1 - w) \times \text{N}(\texttt{m}, \texttt{v})$$

A Beta prior is assumed for the weight parameter

$$w \sim \text{Beta}(x, y)$$

Value

The marginal posterior density for the mixture weight.

Author(s)

Samuel Pawel, Roberto Macri Demmartino

Examples

```
w <- seq(0, 1, length.out = 100)
post <- wposteriormix(w = w, tr = 0.44, sr = 0.04, to = 0.21, so = 0.05,
                      x = 1, y = 1, m = 0, v = 4)
plot(w, post, type = "l", xlab = "Mixture weight",
     ylab = "Marginal posterior density", las = 1)
```

Index