Package 'ESTER'

October 12, 2022

Title Efficient Sequential Testing with Evidence Ratios

Version 0.2.0

Date 2017-12-10

Description An implementation of sequential testing that uses evidence ratios computed from the weights of a set of models. These weights correspond either to Akaike weights computed from the Akaike Information Criterion (AIC) or the Bayesian Information Criterion (BIC) and following Burnham & Anderson (2004, <doi:10.1177/0049124104268644>) recommendations, or to pseudo-BMA weights computed from the WAIC or the LOO-IC of models fitted with 'brms' and following Yao et al. (2017, <arXiv:1704.02030v3>).

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LazyData yes

RoxygenNote 6.0.1

Depends R (>= 3.3.0)

Imports brms, lme4, dplyr, magrittr, tidyr, ggplot2, rlang, foreach, doParallel, cowplot

URL https://github.com/lnalborczyk/ESTER

BugReports https://github.com/lnalborczyk/ESTER/issues

Suggests knitr, rmarkdown

VignetteBuilder knitr

NeedsCompilation no

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Repository CRAN

Date/Publication 2017-12-10 14:21:14 UTC

R topics documented:

`aic` *Computes the Akaike Information Criterion*

Description

Computes the Akaike Information Criterion of a model. Except when the number of observations is much larger than the number of parameters (i.e., n / k > 40), we apply the second-order bias correction for small samples (AICc), as suggested by Burnham & Anderson (2002, 2004).

Usage

```
aic(mod)
```

Arguments

`mod`	A fitted model of class `lm` or `merMod`.

Author(s)

Ladislas Nalborczyk <<ladislas.nalborczyk@gmail.com>>

References

Burnham, K. P., \& Anderson, D. R. (2002). Model Selection and Multimodel Inference: A Practical Information-Theoretical Approach. 2d ed. New York: Springer-Verlag.

Burnham, K. P., \& Anderson, D. R. (2004). Multimodel inference: Understanding AIC and BIC in model selection. Sociological Methods and Research, 33(2), 261-304.

See Also

`bic`, `ictab`

Examples

```
data(mtcars)
mod1 <- lm(mpg ~ cyl, mtcars)
aic(mod1)
```

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analysER *Analysing the results of simulations ran with* simER

Description

Analysing the results of simulations ran with simER. It computes the average sample number (ASN) at which the boundary is attained (either the lower or the upper one), the percentage of hits of the lower boundary as well as hits of the upper boundary, and the percentage of trajectories that did not hit none of the boundaries.

Usage

```
analysER(sim)
```

Arguments

sim	A simER or a compER object.

Value

An object of class data.frame, which contains the average sample number (ASN) at which the boundary is attained (either the lower or the upper one), the percentage of hits of the lower boundary as well as hits of the upper boundary, and the percentage of trajectories that did not hit none of the boundaries (and thus end at nmax).

Author(s)

Ladislas Nalborczyk <<ladislas.nalborczyk@gmail.com>>

See Also

simER

Examples

```
## Not run:
library(ESTER)
sim <- simER(cohensd = 0.8, nmin = 20, nmax = 100, boundary = 10, nsims = 100, ic = bic)
analysER(sim)

## End(Not run)
```

bic *Computes the Bayesian Information Criterion*

Description

Computes the Bayesian Information Criterion of a model (Schwarz, 1978).

Usage

```
bic(mod)
```

Arguments

mod	A fitted model of class lm or merMod.

Author(s)

Ladislas Nalborczyk <<ladislas.nalborczyk@gmail.com>>

References

Schwarz, G. (1978). Estimating the dimension of a model. Annals of Statistics, 6, 461-464.

See Also

aic, ictab

Examples

```
data(mtcars)
mod1 <- lm(mpg ~ cyl, mtcars)
bic(mod1)
```

distER *Simulating many sequential testing with evidence ratios and plotting their distribution*

Description

Simulating many sequential evidence ratios using simER, keeps the last of each simulation, and plotting their distribution.

Usage

```
distER(cohensd, nmin, nmax, nsims, ic = bic)
```

Arguments

cohensd	Expected effect size
nmin	Minimum sample size from which start computing ERs
nmax	Maximum sample size at which stop computing ERs
nsims	Number of experiments to simulate.
ic	Indicates whether to use the aic or the bic

Author(s)

Ladislas Nalborczyk <<ladislas.nalborczyk@gmail.com>>

See Also

simER

Examples

```
## Not run: distER(cohensd = 0.6, nmin = 20, nmax = 100, nsims = 100, ic = bic)
```

ESTER *Efficient Sequential Testing with Evidence Ratios*

Description

The **ESTER** package implements sequential testing based on evidence ratios computed from the Akaike weights of a set of models. These weights are being computed using either the Akaike Information Criterion (AIC) or the Bayesian Information Criterion (BIC).

Details

See `vignette("ESTER")` for a general introduction and overview.

Author(s)

Ladislas Nalborczyk
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See Also

ictab, simER, seqER

ictab *Computes Akaike weights or pseudo-BMA weights for a set of models*

Description

Returns a table with weights of a set of models, based on various information criteria. Currently, `ictab` supports the computation of Akaike weights from the `aic` or the `bic` computed on `lm` or `merMod` models, as well as the computation of pseudo-BMA weights, computed from the WAIC or LOOIC of `brmsfit` models.

Usage

```
ictab(mods, ic, ...)
```

Arguments

`mods`	Should be a named list of models, of class `lm`, `merMod` or `brmsfit`.
`ic`	Indicates which information criterion to use. Current supported information criteria include `aic` and `bic` for `lm` and `merMod` models, as well as `WAIC` and `LOO` for `brmsfit` models.
`...`	Additional parameters to be passed to `brms::WAIC` or `brms::LOO` functions.

Value

An object of class `data.frame`, which contains the value of the information criterion (either AIC, BIC, WAIC or LOOIC), the number of parameters (k for AIC and BIC or p for WAIC or LOOIC), the delta_IC (for AIC and BIC) or the elpd for models compared with WAIC or LOOIC, and the weight of each model (Akaike weights for AIC or BIC and pseudo-BMA weights for WAIC or LOOIC).

Author(s)

Ladislas Nalborczyk <<ladislas.nalborczyk@gmail.com>>

References

Burnham, K. P., \& Anderson, D. R. (2002). Model Selection and Multimodel Inference: A Practical Information-Theoretical Approach. 2d ed. New York: Springer-Verlag.

Burnham, K. P., \& Anderson, D. R. (2004). Multimodel inference: Understanding AIC and BIC in model selection. Sociological Methods and Research, 33(2), 261-304.

Yao, Y. P., Vehtari, A., Simpson, D., \& Gelman, A. (2017). Using stacking to average Bayesian predictive distributions.

See Also

`aic`, `bic`

Examples

```
library(ESTER)
data(mtcars)
mod1 <- lm(mpg ~ cyl, mtcars)
mod2 <- lm(mpg ~ cyl + vs, mtcars)
mod3 <- lm(mpg ~ cyl + vs + I(vs^2), mtcars)
mod4 <- lm(mpg ~ cyl * vs, mtcars)
mods <- list(mod1 = mod1, mod2 = mod2, mod3 = mod3, mod4 = mod4)
ictab(mods, aic)
ictab(mods, bic)

## Not run:
library(brms)
mod1 <- brm(mpg ~ cyl, mtcars)
mod2 <- brm(mpg ~ cyl + vs, mtcars)
mods <- list(m1 = mod1, m2 = mod2)
ictab(mods, LOO, reloo = TRUE, k_threshold = 0.6, cores = 2)

## End(Not run)
```

---

plot.simER *Plotting the results of* simER

Description

Plotting the results of simER.

Usage

```
## S3 method for class 'simER'
plot(x, log = TRUE, hist = TRUE, ...)
```

Arguments

x	A simER object
log	Should the y-axis be log-transformed ?
hist	Should plot the histogram of simulations hitting either the lower, the upper boundary, or stopping at nmax ?
...	Further arguments passed to plot.default

Author(s)

Ladislas Nalborczyk <<ladislas.nalborczyk@gmail.com>>

seqER *Computes sequential evidence ratios*

Description

Computes sequential evidence ratios, either based on the AIC or the BIC. Supported models currently include `lm`, `merMod`, or `brmsfit` models. When data involve repeated measures (and so multiple lines per subject), a column indicating the subject "id" should be provided to the `id` argument. If nothing is passed to the `id` argument, `seqER` will suppose that there is only one observation (i.e., one line) per subject.

Usage

```
seqER(ic = bic, mod1, mod2, nmin = 10, id = NULL, boundary = Inf,
  blind = FALSE, nsims = NULL)
```

Arguments

`ic`	Indicates whether to use the aic or the bic.
`mod1`	A model of class `lm` or `lmerMod`.
`mod2`	A model of class `lm` or `lmerMod` (of the same class of mod1).
`nmin`	Minimum sample size from which start to compute sequential evidence ratios.
`id`	If applicable (i.e., repeated measures), name of the "id" column of your dataframe, in character string.
`boundary`	The Evidence Ratio (or its reciprocal) at which the run is stopped as well
`blind`	If true, the function only returns a "continue or stop" message
`nsims`	Number of permutation samples to evaluate (is ignored if blind = TRUE)

Author(s)

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See Also

`simER`

Examples

```
## Not run:
data(mtcars)
mod1 <- lm(mpg ~ cyl, mtcars)
mod2 <- lm(mpg ~ cyl + disp, mtcars)
seqER(ic = bic, mod1, mod2, nmin = 10)

# Example with ten permutation samples
data(mtcars)
```

```
mod1 <- lm(mpg ~ cyl, mtcars)
mod2 <- lm(mpg ~ cyl + disp, mtcars)
seqER(ic = bic, mod1, mod2, nmin = 10, nsims = 10)

# Example with blinding
data(mtcars)
mod1 <- lm(mpg ~ cyl, mtcars)
mod2 <- lm(mpg ~ cyl + disp, mtcars)
seqER(ic = bic, mod1, mod2, nmin = 10, boundary = 10, blind = TRUE)

# Example with repeated measures
library(lme4)
data(sleepstudy)
mod1 <- lmer(Reaction ~ Days + (1|Subject), sleepstudy)
mod2 <- lmer(Reaction ~ Days + I(Days^2) + (1|Subject), sleepstudy)
seqER(ic = bic, mod1, mod2, nmin = 10, id = "Subject", nsims = 10)

# Example with brmsfit models
library(brms)
mod1 <- brm(Reaction ~ Days + (1|Subject), sleepstudy)
mod2 <- brm(Reaction ~ Days + I(Days^2) + (1|Subject), sleepstudy)
seqER(ic = WAIC, mod1, mod2, nmin = 10, id = "Subject", nsims = 10)

## End(Not run)
```

`seqERboot` *Computes sequential evidence ratios for a given data set and permutation samples*

Description

Computes sequential evidence ratios for a given data set as well as for `order_nb` random permutations of this dataset. When data involve repeated measures (and so multiple lines per subject), a column indicating the subject "id" should be provided to the `id` argument. If nothing is passed to the `id` argument, `seqERboot` will suppose that there is only one observation (i.e., one line) per subject.

Usage

```
seqERboot(ic, mod1, mod2, nmin, id = NULL, order_nb)
```

Arguments

`ic`	Indicates whether to use the aic or the bic.
`mod1`	A model of class `lm` or `lmerMod`.
`mod2`	A model of class `lm` or `lmerMod` (of the same class of mod1).
`nmin`	Minimum sample size from which start to compute sequential evidence ratios.

id	If applicable (i.e., repeated measures), name of the "id" column of your dataframe, in character string.
order_nb	Number of permutation samples to evaluate.

Author(s)

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See Also

seqER

Examples

```
## Not run:
data(mtcars)
mod1 <- lm(mpg ~ cyl, mtcars)
mod2 <- lm(mpg ~ cyl + disp, mtcars)
seqERboot(ic = bic, mod1, mod2, nmin = 10, order_nb = 20)
## End(Not run)
```

---

simER *Simulates sequential testing with evidence ratios*

Description

Simulates one or many sequential testing with evidence ratios from independent two-groups comparisons, as a function of sample size and standardized mean difference. Evidence ratios are computed from the so-called Akaike weights from either the Akaike Information Criterion or the Bayesian Information Criterion.

Usage

```
simER(cohensd = 0, nmin = 20, nmax = 100, boundary = 10, nsims = 20,
  ic = bic, cores = 2, verbose = FALSE)
```

Arguments

cohensd	Expected effect size
nmin	Minimum sample size from which start computing ERs
nmax	Maximum sample size at which stop computing ERs
boundary	The Evidence Ratio (or its reciprocal) at which the run is stopped as well
nsims	Number of simulated samples (should be dividable by cores)
ic	Indicates whether to use the aic or the bic
cores	Number of parallel processes. If cores is set to 1, no parallel framework is used (default is two cores).
verbose	Show output about progress

Value

An object of class `data.frame`, which contains...

Author(s)

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See Also

`ictab`, `analysER`

Examples

```
## Not run:
sim <- simER(cohensd = 0.8, nmin = 20, nmax = 100, boundary = 10,
nsims = 100, ic = bic, cores = 2, verbose = TRUE)
plot(sim, log = TRUE, hist = TRUE)

## End(Not run)
```

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