Package 'confintROB'

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Type Package

Title Confidence Intervals for Robust and Classical Linear Mixed Model Estimators

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Maintainer Fabio Mason <fabio.mason@unige.ch>

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Description The main function calculates confidence intervals (CI) for Mixed Models, utilizing both classical estimators from the lmer() function in the 'lme4' package and robust estimators from the rlmer() function in the 'robustlmm' package, as well as the varComprob() function in the 'robustvarComp' package. Three methods are available: the classical Wald method, the wild bootstrap, and the parametric bootstrap. Bootstrap methods offer flexibility in obtaining lower and upper bounds through percentile or BCa methods. More details are given in Mason, F., Cantoni, E., & Ghisletta, P. (2021) <doi:10.5964/meth.6607> and Mason, F., Cantoni, E., & Ghisletta, P. (2024) <doi:10.1037/met0000643>.

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RoxygenNote 7.3.3

NeedsCompilation no

Depends R (>= 3.5.0)

Imports foreach, lme4, MASS, mvtnorm, tidyr, methods

Suggests robustlmm (>= 3.1-1), robustvarComp (>= 0.1-7), lmerTest (>= 3.1-3), testthat (>= 3.0.0), xtable, ggplot2, parallel, doParallel

Config/testthat/edition 3

LazyData true

Author Fabio Mason [aut, cre],
Manuel Koller [aut],
Eva Cantoni [ctb, ths],
Paolo Ghisletta [ths]

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`confintROB` *Confidence Intervals for Robust and Classical Linear Mixed Model Estimators.*

Description

Confidence Intervals (CIs) based on parametric and semi-parametric bootstrap (and Wald-type) for robust and classical Linear Mixed Models estimators.

Usage

```
confintROB(
  object,
  parm,
  level = 0.95,
  method = c("boot", "BCa", "Wald"),
  nsim = 5000,
  boot.type = c("wild", "parametric"),
  clusterID,
  verify.saved = NULL,
  .export = NULL,
  varComprob.data,
  varComprob.random,
  ...
)
```

Arguments

`object`	an object of class `lmerMod`, `rlmerMod` or `varComprob`
`parm`	parameters for which intervals are sought. Specified by an integer vector of positions (see example) or a character vector of parameter names. Fixed effects parameters are ordered according their appearance in the formula. For the order of variance components, see argument `order` of the `varCorr` function from package `lme4`. By default, the CIs of all the parameters of the model are computed.
`level`	confidence level in]0; 1[
`method`	type of CIs: `"Wald"`, `"boot"`, `"BCa"`
`nsim`	number of bootstrap samples, positive integer
`boot.type`	type of bootstrap: `"wild"` or `"parametric"`

clusterID — clustering variable for method "BCa" (jackknife) and for boot.type "wild" (all observations of a cluster get the same bootstrap weight). For varComprob objects, it is required and gives the name of the clustering variable in varComprob.data. For lmerMod and rlmerMod objects, it is either the name of a grouping factor of the model or a vector with one value per observation. By default, the coarsest grouping factor that contains all the others is used, e.g., batch for (1 | batch/cask). Models with crossed grouping factors have no independent clusters and require clusterID.

verify.saved — optional result returned by an earlier call to confintROB with identical parameters. Useful to speed up repeated manuscript rendering.

.export — passed on to foreach

varComprob.data — a data frame object used to fit the original model. This is only required for the varComprob objects

varComprob.random — text variable describing the random effect structure as it would be written with lmer from lme4. This is only required for the varComprob objects

... — additional arguments passed on to lmer (if applicable)

Details

Implements the classical Wald-type CI, the parametric and the wild bootstrap (Modugno & Giannerini, 2013) for linear mixed models estimated with the robust estimators in rlmer (Koller, 2016; Koller & Stahel, 2022) and varComprob (Agostinelli & Yohai, 2016) and the classical estimators in lmer (Bates et al., 2013). For bootstrap methods, percentile, Bias-Corrected, and accelerated (BCa) versions are available. All these versions are tested in Mason, Cantoni & Ghisletta (2021, 2024).

confintROB computes 5 types of CIs based on arguments method and boot.type.

method:

- "Wald": CIs computation is based on standard error estimates

- "boot": CIs are computed using the respective percentile of estimates obtained on bootstrap sample(s) based on the confidence level

- "BCa": based on the Jacknife method, the Bias-Corrected and accelerated parameters are computed on the original sample to correct estimates obtained from the bootstrap sample(s)

boot.type (for methods "boot" and "BCa"):

- "parametric": the classical parametric bootstrap scheme is used to create bootstrap sample(s). For each bootstrap sample, both the random effects and the errors are generated anew from the fitted model.

- "wild": the semi-parametric bootstrap scheme is used to create bootstrap sample(s)

Value

a numeric table (matrix with column and row names) of CIs.

References

Agostinelli, C., & Yohai, V. J. (2016). Composite robust estimators for linear mixed models. Journal of the American Statistical Association, 111 (516), 1764-1774. doi:10.1080/01621459.2015.1115358

Bates, D., Machler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. Journal of Statistical Software, 67 (1), 1-48. doi: 10.18637/jss.v067.i01

Koller, M. (2016). robustlmm: An R package for robust estimation of linear mixed-effects models. Journal of Statistical Software, 75 (6), 1-24. doi: 10.18637/jss.v075.i06

Koller, M., & Stahel, W. A. (2022). Robust estimation of general linear mixed effects models. In P. M. Yi & P. K. Nordhausen (Eds.), Robust and multivariate statistical methods. Springer Nature Switzerland AG.

Mason, F., Cantoni, E., & Ghisletta, P. (2021). Parametric and semi-parametric bootstrap-based confidence intervals for robust linear mixed models. Methodology, 17 (4), 271-295. doi: 10.5964/meth.6607

Mason, F., Cantoni, E., & Ghisletta, P. (2024). Linear mixed models and latent growth curve models for group comparison studies contaminated by outliers. Psychological methods. doi: 10.1037/met0000643

Modugno, L., & Giannerini, S. (2013). The wild bootstrap for multilevel models. Communications in Statistics - Theory and Methods, 44 (22), 4812-4825. doi: 10.1080/03610926.2013.80280

See Also

`lmer` `rlmer` `varComprob`

Examples

```
if (require(robustlmm)) {
  model.RSE <- rlmer(Reaction ~ 1 + Days + (Days|Subject),
                     data = sleepstudy)
  CI.RSE <- confintROB(model.RSE, level = .95, boot.type = "wild",
                     parm = c(1,2), # indicates that only CIs
                                    # for the intercept and Days are asked.
                     nsim = 10) # small nsim for speed, in practice use, e.g., 5000
  print(CI.RSE)
}
```

`medication` *The medication data set*

Description

Often used for didactic purposes (Singer & Willett, 2003), and originally discussed in Tomarken, Shelton, Elkins, and Anderson (1997). During seven days, three times a day (from time = 0 to time = 6.667), a sample of n = 64 adults (identified by the variable id) were randomly assigned to either a treatment group (treat=1) or a control group (treat=0) and were required to report their mood (pos).

Usage

```
data(medication)
```

Format

'medication' a data.frame with 5 columns and 1242 rows:

obs row number

id participant number

treat treatment assignment, 1= treatment; 0= control

time time from 0 to 6.667, with increments of 0.333

pos the positive mood score

References

Tomarken, A. J., Shelton, R. C., Elkins, L., & Anderson, T. (1997). Sleep deprivation and antidepressant medication: unique effects on positive and negative affect. In American Psychological Society Meeting, Washington, DC.

Examples

```
data(medication)
str(medication)

# Fit mixed-effects model with lme4
library(lme4)
model.ML <- lmer(pos ~ treat * time + (time | id), data = medication,
                 REML = FALSE)
summary(model.ML)


# Fit robust mixed-effects model with robustlmm
library(robustlmm)
model.RSE <- rlmer(pos ~ treat * time + (time | id), data = medication,
                   method = "DAStau")
compare(model.ML, model.RSE)

# Compute confidence intervals
set.seed(1)
ci <- confintROB(model.RSE, boot.type = "wild", nsim = 100)
ci
```

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