Package 'lmmrobust'

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Type Package

Title Robust Variance Estimators for Linear Mixed-Effects Models

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Description Implements bias-corrected robust variance estimators for linear mixed-effects models, addressing the small-sample downward bias in standard sandwich-type estimators. Also provides tools to compute confidence intervals and hypothesis tests using t-approximations based on the effective sample size determined by the cluster structure.

Depends R (>= 4.0)

Imports lme4, Matrix, stats

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Encoding UTF-8

Contents

`epil` *A epilepsy seizures data*

Description

A longitudinal clinical trial dataset for 59 epilepsy patients. Progabide or placebo was randomly assigned to individual patients and the number of epileptic seizures are recorded on each 2 weeks.

- `subject`: ID variable of participants.
- `trt`: Treatment (progabide or placebo).
- `period`: Follow-up periods (=1,2,3,4).
- `y`: The seizure counts during 2-week periods.
- `base`: Number of seizures at baseline.

- age: Age in years at baseline.
- lbase: Log-transformed base.
- lage: Log-transformed age.

Usage

```
data(epil)
```

Format

A data frame with 236 observations.

References

Thall, P. F. and Vail, S. C. (1990). Some covariance models for longitudinal count data with over-dispersion. *Biometrics* **46**, 657-671.

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lmmrobust *Robust Variance Estimators for Linear Mixed-Effects Models*

Description

Compute cluster-robust covariance estimators for fixed effects in linear mixed models using several small-sample corrections.

Usage

```
lmmrobust(fit, cluster=NULL, type=c("RO","MD","FG","FZ","MB"),
conf.level=0.95, inference=c("z","t","both"))
```

Arguments

fit	An lmerMod object obtained from lme function in lme4.
cluster	Optional cluster IDs.
type	Type of robust covariance estimator (RO: ordinary robust variance estimator, MD: Mancl-DeRouen estimator, FG: Fay-Graubard estimator, FZ: Fan-Zhang estimator, MB: Morel-Bokossa estimator).
conf.level	Confidence level (default: 0.95).
inference	Quantile used in confidence intervals and test statistics (z: normal distribution, t: t-distribution, both: both outputs are provided.

Value

A data frame of robust inference results is provided.

References

Fan, C., Zhang, D., and Zhang, C. H. (2012). Robust small-sample inference for fixed effects in general Gaussian linear models. *Journal of Biopharmaceutical Statistics* **22**, 544-564.

Fay, M. P., and Graubard, B. I. (2001). Small-sample adjustments for Wald-type tests using sandwich estimators. *Biometrics* **57**, 1198-1206.

Gosho, M., Noma, H., and Maruo, K. (2021). Practical review and comparison of modified covariance estimators for linear mixed models in small-sample longitudinal studies with missing data. *International Statistical Review* **89**, 550-572.

Mancl, L. A., and DeRouen, T. A. (2001). A covariance estimator for GEE with improved small-sample properties. *Biometrics* **57**, 126-134.

Morel, J. G., Bokossa, M., and Neerchal, N. (2003). Small sample correction for the variance of GEE estimators. *Biometrical Journal* **45**, 395-409.

Noma, H. and Tsubaki, H. (2025). Estimation of absolute effect measures in multilevel model analyses. Forthcoming.

White, H. (1982). Maximum likelihood estimation of misspecified models. *Econometrica* **50**, 1-25.

Examples

```
data(epil)

lmm3 <- lmer(y ~ trt + lbase + lage + (1|subject), data=epil)
lmmrobust(lmm3, type="RO", inference="z")
lmmrobust(lmm3, type="MD", inference="z")
lmmrobust(lmm3, type="FG", inference="t")
lmmrobust(lmm3, type="MB", inference="t")
```

`mch` *A cluster-randomised trial dataset for the maternal and child health handbook*

Description

A cluster-randomised trial dataset with binomial outcome.

- `ID`: ID variable of participants.
- `SOUM`: ID variable of soums (involving 18 soums).
- `x`: Binary variable specifying intervention groups (1=Intervention, 0=Control).
- `mage`: Mother's age.
- `medu`: Mother's education (1=uneducated, 2=elementary, 3=incomplete secondary, 4=complete secondary, 5=incomplete high, 6=high (completed collage or university)).
- `mmarry`: Mother's marital status (1=single, 2=married/cohabitating, 3=separated/divorce, 4=windowed/other).
- `mprig1`: First pregnancy (1=Yes, 2=No).
- `height`: Mother's height.
- `weight`: Mother's weight.
- `time`: Travel time from mother's home to antenatal care clinic.
- `Y`: Outcome variable: Number of antenatal visits.
- `y`: Outcome variable: Whether the number of antenatal visits is >= 6 (0 or 1).
- `ses`: Quintile groups by the social-economic index (= 1, 2, 3, 4, 5).

Usage

```
data(mch)
```

Format

A data frame with 500 participants with 18 soums.

References

Mori, R., Yonemoto, N., Noma, H., et al. (2015). The Maternal and Child Health (MCH) handbook in Mongolia: a cluster-randomized, controlled trial. *PloS One* **10**: e0119772.

Index