Package 'lmeVarComp'

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Type Package

Title Testing for a subset of variance components in linear mixed models

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Description Test zero variance components in linear mixed models and test additivity in nonparametric regression using the restricted likelihood ratio test and the generalized F-test.

License GPL (>= 2)

Suggests RLRsim, varComp

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lmeVarComp *Testing for a Subset of Variance Components in Linear Mixed Models*

Description

This package provides functions to test zero variance components in linear mixed models and test additivity in nonparametric regression, using the restricted likelihood ratio test and the generalized F-test.

Details

Package:	lmeVarComp
Type:	Package
Version:	1.0
Date:	2014-08-27
License:	GPL (>= 2)

The main functions are:

- `test.varcomp` and `rlr.test` for testing zero variance components in linear mixed models.
- `test.additivity` for testing additivity in nonparametric regression.

Author(s)

Yichi Zhang

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References

Zhang, Y., Staicu, A.-M., and Maity, A. (2014). Testing for a Subset of Variance Components in Linear Mixed Models with Application to Testing for Additivity. Submitted.

mnls *Minimum Norm Least Squares*

Description

`mnls` computes the minimum norm solution to the least squares problem.

Usage

```
mnls(x, y, rcond = 1e-10)
```

Arguments

x	design matrix of dimension n by p.
y	response vector of length n, or response matrix of dimension n by q.
rcond	reciprocal condition number to determine the effective rank of x.

Details

The underlying C code calls the LAPACK routine DGELSY.

Value

The least squares solution, as a p by q matrix. It has an attribute called rank, which is the effective rank of x.

Author(s)

Yichi Zhang

Examples

```
x <- matrix(rnorm(500L), 100L, 5L)
x <- cbind(x, x[, 1L] + x[, 2L], x[, 1L] - x[, 3L])
b <- -3L : 3L
y <- c(x %*% b)
mnls(x, y)  # different to b
```

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pseudo.rlr.test *Pseudo Restricted Likelihood Ratio Test for Zero Variance Components*

Description

pseudo.rlr.test tests whether certain variance components are zeros using pseudo restricted likelihood ratio test, assuming the variance components of interest are equal. This function is a wrapper of the RLRTSim function in the RLRsim package.

Usage

```
pseudo.rlr.test(Y, X, Z, Sigma, m0, nsim = 5000L, seed = 130623L)
```

Arguments

Y	response vector of length n
X	fixed effects design matrix of dimension n by p
Z	a list of random effects design matrices. Each matrix should have n rows.

`Sigma`	a list of random effects correlation structures. Each matrix should be symmetric and positive definite, and match the dimension of the corresponding random effects design matrix.
`m0`	an integer indicating the number of nuisance variance components. Should be between `0` and `length(Z) - 1`. The first `m0` variance components will be treated as nuisance.
`nsim`	number of simulations from the null distribution. If zero, REML estimates are computed but tests are not performed.
`seed`	a seed to be set before simulating from the null distribution.

Value

A vector of the test statistic and the p-value of pseudo restricted likelihood ratio test.

Author(s)

Yichi Zhang

References

Greven, S., Crainiceanu, C. M., Kuchenhoff, H., and Peters, A. (2008). Restricted likelihood ratio testing for zero variance components in linear mixed models. *Journal of Computational and Graphical Statistics*, 17(4):870–891.

See Also

`rlr.test`, `score.test`

Examples

```
# two-way random effects ANOVA
n1 <- 5L
n2 <- 6L
n0 <- 4L
n <- n1 * n2 * n0
X <- cbind(rep(1, n))
A <- gl(n1, n2 * n0)
Z1 <- model.matrix(~ -1 + A, contrasts.arg = contr.treatment)
B <- rep(gl(n2, n0), n1)
Z2 <- model.matrix(~ -1 + B, contrasts.arg = contr.treatment)
Z3 <- model.matrix(~ -1 + B : A, contrasts.arg = contr.treatment)
set.seed(1L)
Y <- (X %*% 1
  + Z1 %*% rnorm(ncol(Z1), 0, 0.7)
  + Z2 %*% rnorm(ncol(Z2), 0, 0.3)
  + Z3 %*% rnorm(ncol(Z3), 0, 0.5)
  + rnorm(n, 0, 1))
Z <- list(Z1, Z2, Z3)
Sigma <- lapply(Z, function(z) diag(ncol(z)))
# tests interaction effects
```

```
pseudo.rlr.test(Y, X, Z, Sigma, 2L, 2000L, 2L)
# tests overall effects
pseudo.rlr.test(Y, X, Z, Sigma, 1L, 2000L, 3L)
```

`rlr.test` *Restricted Likelihood Ratio Test and Generalized F-test for Zero Variance Components*

Description

`rlr.test` tests whether certain variance components are zeros using restricted likelihood ratio test and generalized F-test.

Usage

```
rlr.test(Y, X, Z, Sigma, m0, nsim = 5000L, seed = 130623L)
```

Arguments

`Y`	response vector of length `n`
`X`	fixed effects design matrix of dimension `n` by `p`
`Z`	a list of random effects design matrices. Each matrix should have `n` rows.
`Sigma`	a list of random effects correlation structures. Each matrix should be symmetric and positive definite, and match the dimension of the corresponding random effects design matrix.
`m0`	an integer indicating the number of nuisance variance components. Should be between `0` and `length(Z) - 1`. The first `m0` variance components will be treated as nuisance.
`nsim`	number of simulations from the null distribution. If zero, REML estimates are computed but tests are not performed.
`seed`	a seed to be set before simulating from the null distribution.

Value

A list containing the following components:

`RLRT`	a vector of the test statistic and the p-value of restricted likelihood ratio test.
`GFT`	a vector of the test statistic and the p-value of generalized F-test.
`H0.estimate`	REML estimate of variance components (including the error term) under the null hypothesis.
`H1.estimate`	REML estimate of variance components (including the error term) under the alternative hypothesis.

Author(s)

Yichi Zhang

References

Zhang, Y., Staicu, A.-M., and Maity, A. (2014). Testing for a Subset of Variance Components in Linear Mixed Models with Application to Testing for Additivity. Submitted.

See Also

pseudo.rlr.test, score.test

Examples

```
# two-way random effects ANOVA
n1 <- 5L
n2 <- 6L
n0 <- 4L
n <- n1 * n2 * n0
X <- cbind(rep(1, n))
A <- gl(n1, n2 * n0)
Z1 <- model.matrix(~ -1 + A, contrasts.arg = contr.treatment)
B <- rep(gl(n2, n0), n1)
Z2 <- model.matrix(~ -1 + B, contrasts.arg = contr.treatment)
Z3 <- model.matrix(~ -1 + B : A, contrasts.arg = contr.treatment)
set.seed(1L)
Y <- (X %*% 1
  + Z1 %*% rnorm(ncol(Z1), 0, 0.7)
  + Z2 %*% rnorm(ncol(Z2), 0, 0.3)
  + Z3 %*% rnorm(ncol(Z3), 0, 0.5)
  + rnorm(n, 0, 1))
Z <- list(Z1, Z2, Z3)
Sigma <- lapply(Z, function(z) diag(ncol(z)))
# tests interaction effects
rlr.test(Y, X, Z, Sigma, 2L, 2000L, 2L)
# tests overall effects
rlr.test(Y, X, Z, Sigma, 1L, 2000L, 3L)
```

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score.test *Linear Score Test for Zero Variance Components*

Description

score.test tests whether certain variance components are zeros using linear score test. This function is a wrapper of the varComp.test function in the varComp package.

Usage

```
score.test(Y, X, Z, Sigma, m0)
```

Arguments

Y	response vector of length n
X	fixed effects design matrix of dimension n by p
Z	a list of random effects design matrices. Each matrix should have n rows.
Sigma	a list of random effects correlation structures. Each matrix should be symmetric and positive definite, and match the dimension of the corresponding random effects design matrix.
m0	an integer indicating the number of nuisance variance components. Should be between 0 and length(Z) - 1. The first m0 variance components will be treated as nuisance.

Details

To be added.

Value

A vector of the test statistic and the p-value of linear score test.

Author(s)

Yichi Zhang

References

Qu, L., Guennel, T., and Marshall, S. L. (2013). Linear score tests for variance components in linear mixed models and applications to genetic association studies. *Biometrics*, 69(4):883–892.

See Also

rlr.test, pseudo.rlr.test

Examples

```
# two-way random effects ANOVA
n1 <- 5L
n2 <- 6L
n0 <- 4L
n <- n1 * n2 * n0
X <- cbind(rep(1, n))
A <- gl(n1, n2 * n0)
Z1 <- model.matrix(~ -1 + A, contrasts.arg = contr.treatment)
B <- rep(gl(n2, n0), n1)
Z2 <- model.matrix(~ -1 + B, contrasts.arg = contr.treatment)
Z3 <- model.matrix(~ -1 + B : A, contrasts.arg = contr.treatment)
set.seed(1L)
Y <- (X %*% 1
  + Z1 %*% rnorm(ncol(Z1), 0, 0.7)
  + Z2 %*% rnorm(ncol(Z2), 0, 0.3)
```

```
  + Z3 %*% rnorm(ncol(Z3), 0, 0.5)
  + rnorm(n, 0, 1))
Z <- list(Z1, Z2, Z3)
Sigma <- lapply(Z, function(z) diag(ncol(z)))
# tests interaction effects
score.test(Y, X, Z, Sigma, 2L)
# tests overall effects
score.test(Y, X, Z, Sigma, 1L)
```

`test.additivity` *Testing Additivity in Nonparametric Regression*

Description

`test.additivity` tests for additive model in nonparametric regression using mixed model representation and variance components testing.

Usage

```
test.additivity(x, y, type = c("RLR", "pseudo", "score"),
  nbasis = 10L, kernel = c("gaussian", "polynomial", "spline"),
  nsim = 5000L, seed = 130623L)
```

Arguments

`x`	design matrix. Each column should be scaled to have range within `[0,1]`.
`y`	response vector.
`type`	test to be performed: `RLR` for restricted likelihood ratio test and generalized F-test, `pseudo` for pseudo restricted likelihood ratio test assuming the variance components of interest are equal, and `score` for linear score test.
`nbasis`	number of basis functions in additive modeling.
`kernel`	reproducing kernel for non-additive modeling.
`nsim`	number of simulations from the null distribution.
`seed`	a seed to be set before simulating from the null distribution.

Value

A vector of test statistic and p-value.

Author(s)

Yichi Zhang

References

Zhang, Y., Staicu, A.-M., and Maity, A. (2014). Testing for a Subset of Variance Components in Linear Mixed Models with Application to Testing for Additivity. Submitted.

Examples

```
set.seed(20L)
x <- matrix(runif(200L), 100L, 2L)
y <- 4 * x[, 1L] * x[, 2L] + rnorm(100L)
test.additivity(x, y)
```

`test.varcomp` *Testing Zero Variance Components in Linear Mixed Models*

Description

`test.varcomp` tests whether certain variance components are zeros. This function provides a formula interface to the `rlr.test`, `pseudo.rlr.test`, and `score.test` functions.

Usage

```
test.varcomp(fixed, random, test, data = NULL, Sigma = NULL,
  type = c("RLR", "pseudo", "score"), nsim = 5000L, seed = 130623L,
  keep.matrices = FALSE)
```

Arguments

`fixed`	a two-sided formula specifying the response and the fixed effects.
`random`	a one-sided formula specifying the random effects (not including the error term).
`test`	an integer vector of the indices of random effects to be tested.
`data`	an optional data frame, list or environment containing the variables in the model.
`Sigma`	an optional list of symmetric and positive definite matrices specifying the correlation structures of random effects. If `NULL`, default to identity matrices.
`type`	test to be performed: `RLR` for restricted likelihood ratio test and generalized F-test, `pseudo` for pseudo restricted likelihood ratio test assuming the variance components of interest are equal, and `score` for linear score test.
`nsim`	number of simulations from the null distribution.
`seed`	a seed to be set before simulating from the null distribution.
`keep.matrices`	whether the design matrices for fixed effects and random effects, as well as the response vector, will be returned.

Value

A list containing the following components:

`RLRT`	If `type` is `RLR`, a vector of the test statistic and the p-value of restricted likelihood ratio test.
`GFT`	If `type` is `RLR`, a vector of the test statistic and the p-value of generalized F-test.
`pseudo`	If `type` is `pseudo`, a vector of the test statistic and the p-value of pseudo restricted likelihood ratio test.

score	If type is score, a vector of the test statistic and the p-value of linear score test.
Y	If keep.matrices is TRUE, the response.
X	If keep.matrices is TRUE, the fixed effects design matrix.
Z	If keep.matrices is TRUE, a list of the random effects design matrices.
Sigma	If keep.matrices is TRUE, a list of the random effects correlation structures.

Author(s)

Yichi Zhang

See Also

rlr.test, pseudo.rlr.test, score.test

Examples

```
n1 <- 5L
n2 <- 6L
n0 <- 4L
A <- gl(n1, n2 * n0)
B <- rep(gl(n2, n0), n1)
set.seed(1L)
Y <- 1 + rnorm(n1, 0, 0.7)[A] + rnorm(n2, 0, 0.3)[B] +
  rnorm(n1 * n2, 0, 0.5)[A : B] + rnorm(n1 * n2 * n0, 0, 1)
test.varcomp(Y ~ 1, ~ -1 + A + B + A:B, test = c(2L, 3L),
  nsim = 2000L, seed = 2L)
```

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