Package 'HMMEsolver'

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Type Package

Title A Fast Solver for Henderson Mixed Model Equation via Row Operations

Version 0.1.2

Description
Consider the linear mixed model with normal random effects. A typical method to solve Henderson's Mixed Model Equations (HMME) is recursive estimation of the fixed effects and random effects. We provide a fast, stable, and scalable solver to the HMME without computing matrix inverse. See Kim (2017) <doi:10.48550/arXiv.1710.09663> for more details.

License GPL (>= 3)

Encoding UTF-8

LazyData true

Imports Rcpp, Rdpack

LinkingTo Rcpp, RcppArmadillo

RdMacros Rdpack

RoxygenNote 6.1.1

NeedsCompilation yes

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HMMEsolver-package *HMMEsolver Package*

Description

Consider the linear mixed model with normal random effects,

$$Y = X\beta + Zv + \epsilon$$

where β and v are vectors of fixed and random effects. One of most popular methods to solve the Henderson's Mixed Model Equation related to the problem is EM-type algorithm. Its drawback, however, comes from repetitive matrix inversion during recursive estimation steps. Kim (2017) proposed a novel method of avoiding such difficulty, letting the estimation more fast, stable, and scalable.

SolveHMME *Solve Henderson's Mixed Model Equation.*

Description

Consider a linear mixed model with normal random effects,

$$Y_{ij} = X_{ij}^T\beta + v_i + \epsilon_{ij}$$

where $i = 1, \ldots, n, \quad j = 1, \ldots, m$, or it can be equivalently expressed using matrix notation,

$$Y = X\beta + Zv + \epsilon$$

where $Y \in \mathrm{R}^{nm}$ is a known vector of observations, $X \in \mathrm{R}^{nm \times p}$ and $Z \in \mathrm{R}^{nm \times n}$ design matrices for β and v respectively, $\beta \in \mathrm{R}^p$ and $v \in \mathrm{R}^n$ unknown vectors of fixed effects and random effects where $v_i \sim N(0, \lambda_i)$, and $\epsilon \in \mathrm{R}^{nm}$ an unknown vector random errors independent of random effects. Note that Z does not need to be provided by a user since it is automatically created accordingly to the problem specification.

Usage

```
SolveHMME(X, Y, Mu, Lambda)
```

Arguments

X	an $(nm \times p)$ design matrix for β.
Y	a length-nm vector of observations.
Mu	a length-nm vector of initial values for $\mu_i = E(Y_i)$.
Lambda	a length-n vector of initial values for λ, variance of $v_i \sim N(0, \lambda_i)$

Value

a named list containing

beta a length-p vector of BLUE $\hat{beta}$.

v a length-n vector of BLUP $\hat{v}$.

leverage a length-$(mn + n)$ vector of leverages.

References

Henderson CR, Kempthorne O, Searle SR, von Krosigk CM (1959). "The Estimation of Environmental and Genetic Trends from Records Subject to Culling." *Biometrics*, **15**(2), 192. ISSN 0006341X, doi: 10.2307/2527669, http://www.jstor.org/stable/2527669?origin=crossref.

Robinson GK (1991). "That BLUP is a Good Thing: The Estimation of Random Effects." *Statistical Science*, **6**(1), 15–32. ISSN 0883-4237, doi: 10.1214/ss/1177011926, http://projecteuclid.org/euclid.ss/1177011926.

McLean RA, Sanders WL, Stroup WW (1991). "A Unified Approach to Mixed Linear Models." *The American Statistician*, **45**(1), 54. ISSN 00031305, doi: 10.2307/2685241, http://www.jstor.org/stable/2685241?origin=crossref.

Kim J (2017). "A Fast Algorithm for Solving Henderson's Mixed Model Equation." *ArXiv e-prints*.

Examples

```
## small setting for data generation
n = 100; m = 2; p = 2
nm = n*m;   nmp = n*m*p

## generate artifical data
X = matrix(rnorm(nmp, 2,1), nm,p) # design matrix
Y = rnorm(nm, 2,1)                # observation

Mu = rep(1, times=nm)
Lambda = rep(1, times=n)

## solve
ans = SolveHMME(X, Y, Mu, Lambda)
```

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