Package ‘HMMEsolver’

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Type Package
Title A Fast Solver for Henderson Mixed Model Equation via Row Operations
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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) <arXiv:1710.09663> for more details.
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R topics documented:

HMMEsolver-package .................................................. 2
SolveHMME .............................................................. 2

Index 4
HMMESolver-package  
HMMEsolver Package

Description
Consider the linear mixed model with normal random effects,

\[ Y = X\beta + Zv + \epsilon \]

where \( \beta \) and \( v \) are vectors of fixed and random effects. One of the 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 \( Y \in \mathbb{R}^{nm} \) is a known vector of observations, \( X \in \mathbb{R}^{nm \times p} \) and \( Z \in \mathbb{R}^{nm \times n} \) design matrices for \( \beta \) and \( v \) respectively, \( \beta \in \mathbb{R}^p \) and \( v \in \mathbb{R}^n \) unknown vectors of fixed effects and random effects where \( v_i \sim N(0, \lambda_i) \), and \( \epsilon \in \mathbb{R}^{nm} \) 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 \( \beta \).
- \( Y \) 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 \( \lambda \), variance of \( v_i \sim N(0, \lambda_i) \).
Value

- beta: a length-\( p \) vector of BLUE \( \beta_{\hat{a}} \).
- v: a length-\( n \) vector of BLUP \( \hat{v} \).
- leverage: a length-\((mn + n)\) vector of leverages.

References


Examples

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

## generate artificial data
X = matrix(rnorm(nmp, 2), 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)
```
Index

HMMEsolver-package, 2
SolveHMME, 2