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Description mme fit Gaussian Multinomial mixed-effects models for small area estimation: Model 1, with one random effect in each category of the response variable; Model 2, introducing independent time effect; Model 3, introducing correlated time effect. mme calculates analytical and parametric bootstrap MSE estimators.

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Description

The mme package implements three multinomial area level mixed effects models for small area estimation. The first model (Model 1) is based on the area level multinomial mixed model with independent random effects for each category of the response variable (Lopez-Vizcaino et al, 2013). The second model (Model 2) takes advantage from the availability of survey data from different time periods and uses a multinomial mixed model with independent random effects for each category of the response variable and with independent time and domain random effects. The third model (Model 3) is similar to the second one, but with correlated time random effects. To fit the models, we combine the penalized quasi-likelihood (PQL) method, introduced by Breslow and Clayton (1993) for estimating and predicting the fixed and random effects, with the residual maximum likelihood (REML) method for estimating the variance components. In all models the package uses two approaches to estimate the mean square error (MSE), first through an analytical expression and second by bootstrap techniques.


References


addtolist

Description

This function adds items from a list of dimension d*t, where d is the number of areas and t is the number of time periods.

Usage

addtolist(B_d, t, d)

Arguments

B_d a list in each area.

B_d a list in each area.

t number of time periods.

d number of areas.

Value

B_d a list of dimension d.

See Also

\texttt{fbeta.fit}, \texttt{fbeta.ct}, \texttt{modelfit2}, \texttt{modelfit3}

Examples

k=3 # number of categories for the response variable
pp=c(1,1) # vector with the number of auxiliary variables in each category
data(simdata2) # data
mod=2
datar=data.mme(simdata2,k,pp,mod)

# Add the time periods
l=addtolist(datar$X, datar$t, datar$d)
addtomatrix

Add rows from a matrix

Description

This function adds rows from a matrix of dimension d*t*(k-1) times d*(k-1).

Usage

```r
addtomatrix(cR, d, t, k)
```

Arguments

- `cR`: a matrix of dimension d*t*(k-1) times d*(k-1).
- `d`: number of areas.
- `t`: number of time periods.
- `k`: number of categories of the response variable.

Value

C22 a matrix of dimension d*(k-1) times d*(k-1).

See Also

- `Fbeta.it`, `Fbeta.ct`, `modelfit2`, `modelfit3`

Examples

```r
k=3  # number of categories of the response variable
d=15  # number of areas
t=2   # number of time periods
mat=matrix(1,d*t*(k-1),d*(k-1))  # a matrix

## Add items in the matrix
mat2=addtomatrix(mat,d,t,k)
```
Standard deviation and p-values of the estimated model parameters

Description

This function calculates the standard deviations and the p-values of the estimated model parameters. The standard deviations are obtained from the asymptotic Fisher information matrix in the fitting algorithms \texttt{modelfit1}, \texttt{modelfit2}, \texttt{modelfit3}, depending of the current multinomial mixed model.

Usage

\texttt{ci(a, F)}

Arguments

- \texttt{a} vector with the estimated parameters obtained from \texttt{modelfit1}, \texttt{modelfit2} or \texttt{modelfit3}.
- \texttt{F} inverse of the Fisher Information Matrix obtained from \texttt{modelfit1}, \texttt{modelfit2} or \texttt{modelfit3}.

Value

A list containing the following components.

- \texttt{stdNdev} vector with the standard deviations of the parameters. The parameters are sorted per category.
- \texttt{pNvalue} vector with the p-values of the parameters for testing $H_0: \alpha = 0$.

References


See Also

\texttt{modelfit1}, \texttt{modelfit2}, \texttt{modelfit3}.

Examples

\begin{verbatim}
library(Matrix)

k=3  #number of categories of the response variable
pp=c(1,1)  #vector with the number of auxiliary variables in each category
data(simdata)  #data
mod=1  #Type of model
datar=data.mme(simdata,k,pp,mod)
\end{verbatim}
```r
#Model fit
result=modelfit1(pp,datarXk,datarX,datarZ,datarinitial,datary[,1:(k-1)],
                 datarn,datarn)
beta=result[[8]],1] #fixed effects
Fisher=result[[3]] #Fisher information matrix

#Standard deviation and p-values
res=ci(beta,Fisher)
```

---

data.mme  

**Function to generate matrices and the initial values**

**Description**

Based on the input data, this function generates some matrices that are required in subsequent calculations and the initial values obtained from the function `initial.values`.

**Usage**

```r
data.mme(fi, k, pp, mod)
```

**Arguments**

- `fi` input data set with (d x t) rows and 4+k+sum(pp) columns. The first four columns of the data set are, in this order: the area indicator (integer), the time indicator (integer), the sample size of each domain and the population size of each domain. The following k columns are the categories of the response variable. Then, the auxiliary variables: first, the auxiliary variables of the first category, second, the auxiliary variables of the second category, and so on. Examples of input data sets are in `simdata`, `simdataR` and `simdataS`.
- `k` number of categories of the response variable.
- `pp` vector with the number of auxiliary variables per category.
- `mod` a number specifying the type of models: 1=multinomial mixed model with one independent random effect in each category of the response variable (Model 1), 2=multinomial mixed model with two independent random effects in each category of the response variable: one domain random effect and another independent time and domain random effect (Model 2) and 3= multinomial model with two independent random effects in each category of the response variable: one domain random effect and another correlated time and domain random effect (Model 3).

**Value**

A list containing the following components.

- `n` vector with the area sample sizes.
- `N` vector with the area population sizes.
\textbf{Fbetaf} \hfill 7

| \textbf{Z} | design matrix of random effects. |
| \textbf{Xk} | list of matrices with the auxiliary variables per category. The dimension of the list is the number of domains |
| \textbf{X} | list of matrices with the auxiliary variables. The dimension of the list is the number of categories of the response variable minus one. |
| \textbf{y} | matrix with the response variable. The rows are the domains and the columns are the categories of the response variable. |
| \textbf{initial} | a list with the initial values for the fixed and the random effects obtained from initial.values. |

**References**


**See Also**

\texttt{initial.values, wmatrix, phi.m, prmu, Fbetaf, phi.direct, sPhikf, ci, modelfit1, msef, mseb}

**Examples**

```r
k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
data(simdata2) #Data
mod=2

#Needed matrix and initial values
data=r(data.mme(simdata2,k,pp,mod))
```

---

**Fbetaf**

\textit{Inverse of the Fisher information matrix of the fixed and random effects in Model 1}

**Description**

This function calculates the inverse of the Fisher information matrix of the fixed effects (beta) and the random effects (u) and the score vectors S.beta and S.u, for the model with one independent random effect in each category of the response variable (Model 1). \texttt{modelfit1} uses the output of this function to estimate the fixed and random effects by the PQL method.

**Usage**

\texttt{Fbetaf(sigmap, X, Z, phi, y, mu, u)}
Arguments

- `sigmap` a list with the model variance-covariance matrices for each domain.
- `X` list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable.
- `Z` design matrix of random effects.
- `phi` vector with the values of the variance components obtained from `modelfit1`.
- `y` matrix with the response variable except the reference category. The rows are the domains and the columns are the categories of the response variable minus one.
- `mu` matrix with the estimated mean of the response variable obtained from `prmu`.
- `u` matrix with the values of random effects obtained from `modelfit1`.

Value

A list containing the following components.

- `F.beta.beta` the first diagonal element of the inverse of the Fisher information matrix.
- `F.beta.u` the element out of the diagonal of the inverse of the Fisher information matrix.
- `F.u.u` the second diagonal element of the inverse of the Fisher information matrix.
- `S.beta` beta scores.
- `S.u` u scores.

References


See Also

data.mme, initial.values, wmatrix, phi.mult, prmu, phi.direct, spPhikf, ci, modelfit1, msef, mseb.

Examples

```r
require(Matrix)

k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
data(simdata) #data
mod=1 #type of model
datar=data.mme(simdata,k,pp,mod)
initial=datar$initial
mean=prmu(datar$d,datar$X,initial$beta.0,initial$u.0)
sigmap=wmatrix(datar$d,mean$estimated.probabilities)

#Inverse of the Fisher information matrix
Fisher=Fbetaf(sigmap,datar$X,datar$Z,initial$phi.0,datar$y[,1:(k-1)],
               mean$mean,initial$u.0)
```
Description

This function calculates the score vector $S$ and the inverse of the Fisher information matrix for the fixed ($\beta$) and the random effects ($u_1, u_2$) in Model 3. This model has two independent sets of random effects. The first one contains independent random effects $u_{1dk}$ associated to each category and domain. The second set contains random effects $u_{2dkt}$ associated to each category, domain and time period. Model 3 assumes that the $u_{2dk}$ are AR(1) correlated across time. `modelfit3` uses the output of this function to estimate the fixed and random effect by the PQL method.

Usage

```
Fbetaf.Nct(sigmap, x, Z, phi1, phi2, y, mu, u1, uR, rho)
```

Arguments

- `sigmap`: a list with the model variance-covariance matrices for each domain obtained from `wmatrix`.
- `x`: list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable minus one.
- `Z`: design matrix of random effects.
- `phi1`: vector with the values of the variance components for the first random effects obtained from `modelfit3`.
- `phi2`: vector with the values of the variance components for the second random effects obtained from `modelfit3`.
- `y`: matrix with the response variable, except the reference category. The rows are the domains and the columns are the categories of the response variable minus one.
- `mu`: matrix with the estimated mean of the response variable.
- `u1`: matrix with the values of the first random effect obtained from `modelfit3`.
- `u2`: matrix with the values of the second random effect obtained from `modelfit3`.
- `rho`: vector with the values of the correlation parameter obtained from `modelfit3`.

Value

A list containing the following components.

- $F$: the inverse of the Fisher information matrix of ($\beta, u_1, u_2$).
- $S$: ($\beta, u_1, u_2$) score vectors
References


See Also

data.mme, initial.values, wmatrix, phi.mult.ct, prmu.time, phi.direct.ct, sPhikf.ct, ci, modelfit3, msef.ct, omega, mseb

Examples

require(Matrix)

k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
mod=3 #type of model
data(simdata3)
datar=data.mme(simdata3,k,pp,mod)
initial=datar$initial
mean=prmu.time(datar$X,datar$Xk,initial$beta.0,initial$u1.0,initial$u2.0)
sigmap=wmatrix(datar$X,mean$estimated.probabilities) #variance-covariance

#The inverse of the Fisher information matrix and the score matrix
Fisher.beta=Fbetaf.it(sigmap,datar$X,datar$Z,initial$phi1.0,initial$phi2.0, datar$y[,1:(k-1)],mean$mean,initial$u1.0,initial$u2.0,initial$rho.0)

Description

This function calculates the score vector S and the inverse of the Fisher information matrix for the fixed (beta) and the random effects (u1, u2) in Model 2. This model has two independent sets of random effects. The first one contains independent random effects u1dk associated to each category and domain. The second set contains random effects u2dkt associated to each category, domain and time period. Model 2 assumes that the u2dk are independent across time. modelfit2 uses the output of this function to estimate the fixed and random effect by the PQL method.

Usage

Fbetaf.it(sigmap, X, Z, phi1, phi2, y, mu, u1, u2)
Arguments

- **sigmap**: a list with the model variance-covariance matrices for each domain.
- **X**: list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable minus one.
- **Z**: design matrix of random effects obtained from `data.mme`.
- **phi1**: vector with the first variance component obtained from `modelfit2`.
- **phi2**: vector with the second variance component obtained from `modelfit2`.
- **y**: matrix with the response variable, except the reference category obtained from `data.mme`. The rows are the domains and the columns are the categories of the response variable minus one.
- **mu**: matrix with the estimated mean of the response variable obtained from `prmuNtime`.
- **u1**: matrix with the values of the first random effect obtained from `modelfit2`.
- **u2**: matrix with the values of the second random effect obtained from `modelfit2`.

Value

A list containing the following components.

- **F**: the inverse of the Fisher information matrix.
- **S**: \((\beta, u_1, u_2)\) scores

References


See Also

data.mme, initial.values, wmatrix, phi.mult.it, prmu.time, phi.direct.it, sPhikf.it, ci, modelfit2, msef.it, mseb.

Examples

```r
require(matrixI)
k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
mod=2 #Type of model
data(simdataRI) #data
datar=data.mme(simdataR,k,pp,mod)
initial=datar$initial
mean=prmu.time(datar$n,datar$X,k,initial$beta.0,initial$u1.0,initial$u2.0)
sigmap=wmatrix(datar$n,mean$estimated.probabilities)

#The inverse of the Fisher information matrix of the fixed effects
Fisher=fbetaf.it(sigmap,datar$X,datar$Z,initial$phi.0,initial$phi2.0,
datar$y[,1:(k-1)],mean$mean,initial$u1.0,initial$u2.0)
```
initial.values

Initial values for fitting algorithm to estimate the fixed and random effects and the variance components

Description

This function sets the initial values. An iterative algorithm fits the multinomial mixed models that requires initial values for the fixed effects, the random effects and the variance components. This initial values are used in modelfit1, modelfit2 and modelfit3.

Usage

initial.values(d, pp, datar, mod)

Arguments

d
number of areas.

pp
vector with the number of auxiliary variables per category.

datar
output of function data.mme.

mod
a number specifying the type of model: 1=multinomial mixed model with one independent random effect for each category of the response variable (Model 1), 2=multinomial mixed model with two independent random effects for each category of the response variable: one domain random effect and another independent time and domain random effect (Model 2) and 3= multinomial mixed model with two independent random effects for each category of the response variable: one domain random effect and another correlated time and domain random effect (Model 3).

Value

A list containing the following components, depending on the chosen model.

beta.0
a list with the initial values for the fixed effects beta per category.

phi.0
vector with the initial values for the variance components phi of Model 1.

phi1.0
vector with the initial values for the variance components phi1 of Model 2 or 3.

phi2.0
vector with the initial values for the variance components phi2 of Model 2 or 3.

u
matrix with the initial values for the random effect for Model 1.

u1.0
matrix with the initial values for the first random effect for Model 2 or 3.

u2.0
matrix with the initial values for the second random effect for Model 2 or 3.

rho.0
vector with the initial values for the correlation parameter for Model 3.
References

See Also
data.mme, wmatrix, phi.multiplit, prmu.time, Fbetaf.it, phi.direct.it, sPhik.it, ci, modelfit2, msef.it, mseb

Examples
library(Matrix)

k=3  #number of categories of the response variable
pp=c(1,1)  #vector with the number of auxiliary variables in each category
data(simdata)
D=nrow(simdata)
mod=1  #Type of model
data=data.mme(simdata,k,pp,mod)

## Initial values for fixed, random effects and variance components
initial=data$initial

mmedata  

Create objects of class mmedata

Description
This function creates objects of class mmedata.

Usage
mmedata(fi, k, pp)

Arguments

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<th>Argument</th>
<th>Description</th>
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<td>fi</td>
<td>input data set with (d X t) rows and 4+k+sum(pp) columns. The first four columns of the data set are, in this order: the area indicator (integer), the time indicator (integer), the sample size of each domain and the population size of each domain. The following k columns are the categories of the response variable. Then, the auxiliary variables: first, the auxiliary variables of the first category, second, the auxiliary variables of the second category, and so on. Examples of input data set are in simdata, simdata2 and simdata3.</td>
</tr>
<tr>
<td>k</td>
<td>number of categories of the response variable.</td>
</tr>
<tr>
<td>pp</td>
<td>vector with the number of auxiliary variables per category.</td>
</tr>
</tbody>
</table>
See Also
   modelfit1, modelfit2, modelfit3

Examples
   k=3  #number of categories of the response variable
   pp=c(1,1)  #vector with the number of auxiliary variables in each category
   data(simdata)
   r=mmedata(simdata,k,pp)

model
   Choose between the three models

Description
   This function chooses one of the three models.

Usage
   model(d, t, pp, Xk, X, Z, initial, y, M, MM, mod)

Arguments
   d  number of areas.
   t  number of time periods.
   pp  vector with the number of the auxiliary variables per category.
   Xk  list of matrices with the auxiliary variables per category obtained from data.mme.
       The dimension of the list is the number of domains.
   X  list of matrices with the auxiliary variables obtained from data.mme. The dimension of the list is the number of categories of the response variable minus one.
   Z  design matrix of random effects obtained from data.mme.
   initial  output of the function initial.values.
   y  matrix with the response variable obtained from data.mme. The rows are the domains and the columns are the categories of the response variable.
   M  vector with the area sample sizes.
   MM  vector with the population sample sizes.
   mod  a number specifying the type of models: 1=multinomial mixed model with one independent random effect in each category of the response variable (Model 1), 2=multinomial mixed model with two independent random effects in each category of the response variable: one domain random effect and another independent time and domain random effect (Model 2) and 3= multinomial model with two independent random effects in each category of the response variable: one domain random effect and another correlated time and domain random effect (Model 3).
modelfit1

Value

the output of the function modelfit1, modelfit2 or modelfit3.

References


Examples

```r
k=3  #number of categories of the response variable
pp=c(1,1)  #vector with the number of auxiliary variables in each category
data(simdata)  #data
mod=1  #Model 1
datar=data.mme(simdata,k,pp,mod)
result=model(datar$d,datar$t,pp,datar$Xk,datar$X,datar$Z,datar$initial,datar$y[,1:(k-1)],
datar$n,datar$N, mod)
```

modelfit1  
*Function used to fit Model 1*

Description

This function fits the multinomial mixed model with one independent random effect per category of the response variable (Model 1), like in the formulation described in Lopez-Vizcaíno et al. (2013). The fitting algorithm combines the penalized quasi-likelihood method (PQL) for estimating and predicting the fixed and random effects with the residual maximum likelihood method (REML) for estimating the variance components. This function uses as initial values the output of the function initial.values

Usage

```r
modelfit1(pp, Xk, X, Z, initial, y, M, MM)
```

Arguments

- **pp**  
  vector with the number of the auxiliary variables per category.
- **Xk**  
  list of matrices with the auxiliary variables per category obtained from `data.mme`. The dimension of the list is the number of domains.
- **X**  
  list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable minus one.
- **Z**  
  design matrix of random effects obtained from `data.mme`. 
initial output of the function `initial.values`.
y matrix with the response variable except the reference category obtained from `data.mme`. The rows are the domains and the columns are the categories of the response variable minus 1.
M vector with the area sample sizes.
MM vector with the population sample sizes.

Value

A list containing the following components.
Estimated.probabilities matrix with the estimated probabilities for the categories of response variable.
Fisher.information.matrix.phi Fisher information matrix of the random effect.
Fisher.information.matrix.beta Fisher information matrix of the fixed effect.
u matrix with the estimated random effects.
mean matrix with the estimated mean of the response variable.
warning1 0=OK,1=The model could not be fitted.
warning2 0=OK,1=The value of the variance component is negative: the initial value is taken.
beta.Stddev.p.value matrix with the estimated fixed effects, its standard deviations and its p-values.
phi.Stddev.p.value matrix with the estimated variance components, its standard deviations and its p-values.

References


See Also

`data.mme`, `initial.values`, `wmatrix`, `phi.mult`, `prmu`, `phi.direct`, `sPhikf`, `ci`, `Fbetaf`, `msef`, `mseb`.

Examples

```r
library(Matrix)

k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
data(simdata) #data
mod=1 #type of model
datar=data.mme(simdata,k,pp,mod)
```
modelfit2

```r
# Model fit
result = modelfit1(pp, data$Xk, data$X, data$Z, data$initial, data$y[,1:(k-1)],
                   data$n, data$N)
```

---

modelfit2 | Function to fit Model 2

---

**Description**

This function fits the multinomial mixed model with two independent random effects for each category of the response variable: one domain random effect and another independent time and domain random effect (Model 2). The formulation is described in Lopez-Vizcaino et al. (2013). The fitting algorithm combines the penalized quasi-likelihood method (PQL) for estimating and predicting the fixed and random effects, respectively, with the residual maximum likelihood method (REML) for estimating the variance components. This function uses as initial values the output of the function `initial.values`.

**Usage**

```r
modelfit2(d, t, pp, Xk, X, Z, initial, y, M, MM)
```

**Arguments**

- `d`: number of areas.
- `t`: number of time periods.
- `pp`: vector with the number of the auxiliary variables per category.
- `Xk`: list of matrices with the auxiliary variables per category obtained from `data.mme`. The dimension of the list is the number of domains.
- `X`: list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable minus one.
- `Z`: design matrix of random effects `data.mme`.
- `initial`: output of the function `initial.values`.
- `y`: matrix with the response variable obtained from `data.mme`, except the reference category. The rows are the domains and the columns are the categories of the response variable minus one.
- `M`: vector with the area sample sizes.
- `MM`: vector with the population sample sizes.
Value
A list containing the following components.

- Estimated.probabilities
  - matrix with the estimated probabilities for the categories of response variable.
- Fisher.information.matrix.phi
  - Fisher information matrix of the variance components.
- Fisher.information.matrix.beta
  - Fisher information matrix of the fixed effects.
- u1
  - matrix with the estimated first random effect.
- u2
  - matrix with the estimated second random effect.
- mean
  - matrix with the estimated mean of response variable.
- warning1
  - 0=OK, 1=The model could not be fitted.
- warning2
  - 0=OK, 1=The value of the variance component is negative: the initial value is taken.
- beta.Stddev.p.value
  - matrix with the estimated fixed effects, its standard deviations and its p-values.
- phi.Stddev.p.value
  - matrix with the estimated variance components, its standard deviations and its p-values.

References

See Also
data.mme, initial.values, wmatrix, phi.mult.it, prmu.time, phi.direct.it, sPhikf.it, ci.Fbetaf.it, msef.it, mseb

Examples
library(mixstock)
library(Matrix)
k=3 # number of categories of the response variable
pp=c(1,1) # vector with the number of auxiliary variables in each category
mod=2 # type of model
data(simdata2) # data
datar=data.mme(simdata2,k,pp,mod)

# Model fit
result=modelfit2(datar$d,datar$t,pp,datar$Xk,datar$X,datar$Z,datar$initial,datar$y[,1:(k-1)],
datar$n,datar$N)
**modelfit**

**Function used to fit Model 3**

**Description**

This function fits the multinomial mixed model with two independent random effects for each category of the response variable: one domain random effect and another correlated time and domain random effect (Model 3). The formulation is described in Lopez-Vizcaino et al. (2013). The fitting algorithm combine the penalized quasi-likelihood method (PQL) for estimating and predicting the fixed and random effects, respectively, with the residual maximum likelihood method (REML) for estimating the variance components. This function uses as initial values the output of the function `initial.values`.

**Usage**

```r
modelfit(d, t, pp, Xk, X, Z, initial, y, M, MM, b)
```

**Arguments**

- `d`: number of areas.
- `t`: number of time periods.
- `pp`: vector with the number of the auxiliary variables per category.
- `Xk`: list of matrices with the auxiliary variables per category obtained from `data.mme`. The dimension of the list is the number of domains.
- `X`: list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable minus one.
- `Z`: design matrix of random effects obtained from `data.mme`.
- `initial`: output of the function `initial.values`.
- `y`: matrix with the response variable obtained from `data.mme`, except the reference category. The rows are the domains and the columns are the categories of the response variable minus one.
- `M`: vector with the area sample sizes.
- `MM`: vector with the population sample sizes.
- `b`: parameter that indicates the bootstrap.

**Value**

A list containing the following components.

**Estimated.probabilities**

Matrix with the estimated probabilities for the categories of response variable.

**Fisher.information.matrix.phi**

Fisher information matrix of phi.
Fisher.information.matrix.beta
- Fisher information matrix of beta.

u1  matrix with the estimated first random effect.

u2  matrix with the estimated second random effect.

mean  matrix with the estimated mean of the response variable.

warning1  0=OK, 1=The model could not be fitted.

warning2  0=OK, 1=The value of the variance component is negative: the initial value is taken.

beta.Stddev.p.value
- matrix with the estimated fixed effects, its standard deviations and its p-values.

phi.Stddev.p.value
- matrix with the estimated variance components, its standard deviations and its p-values.

rho  estimated correlation parameter.

rho.Stddev.p.value
- matrix with the estimated correlation parameter, its standard deviations and its p-values.

References

See Also
data.mme, initial.values, wmatrix, phi.mult.ct, prmu.time, phi.direct.ct, sPhikf.ct, omega, ci, Fbetaf.ct, msef.ct, mseb

Examples
## Not run:
library(mixstock)
library(Matrix)
library(MASS)

k=3  # number of categories of the response variable
pp=c(1,1)  # vector with the number of auxiliary variables in each category
mod=3  # type of model
data(simdata3)  # data
datar=data.mme(simdata3,k,pp,mod)

# Model fit
result=modelfit3(datar$d, datar$t, pp, datar$Xk, datar$X, datar$Z, datar$initial, datar$y[,1:(k-1)],
                 datar$n, datar$n, 0)
## End (Not run)
Bias and MSE using parametric bootstrap

Description

This function calculates the bias and the mse for the multinomial mixed effects models using parametric bootstrap. Three types of multinomial mixed models are considered, with one independent domain random effect in each category of the response variable (Model 1), with two random effects: the first, with a domain random effect and with independent time and domain random effect (Model 2) and the second, with a domain random effect and with correlated time and domain random effect (Model 3). See details of the parametric bootstrap procedure in Gonzalez-Manteiga et al. (2008) and in Lopez-Vizcaino et al. (2013) for the adaptation to these three models. This function uses the output of modelfit1, modelfit2 or modelfit3, depending of the current multinomial mixed model.

Usage

mseb(pp, Xk, X, Z, M, MM, resul, B, mod)

Arguments

- **pp** vector with the number of the auxiliary variables per category.
- **Xk** list of matrices with the auxiliary variables per category obtained from data.mme. The dimension of the list is the number of domains.
- **X** list of matrices with the auxiliary variables obtained from data.mme. The dimension of the list is the number of categories of the response variable minus one.
- **Z** design matrix of random effects obtained from data.mme.
- **M** vector with the area sample sizes.
- **MM** vector with the population sample sizes.
- **resul** output of the function modelfit1, modelfit2 or modelfit3.
- **B** number of bootstrap replications.
- **mod** a number specifying the type of models: 1=multinomial mixed model with one independent random effect in each category of the response variable (Model 1), 2=multinomial mixed model with two independent random effects in each category of the response variable: one domain random effect and another independent time and domain random effect (Model 2) and 3= multinomial model with two independent random effects in each category of the response variable: one domain random effect and another correlated time and domain random effect (Model 3).
Value

a list containing the following components.

- **bias.pboot**: BIAS of the parametric bootstrap estimator of the mean of the response variable
- **mse.pboot**: MSE of the parametric bootstrap estimator of the mean of the response variable
- **rmse.pboot**: RMSE of the parametric bootstrap estimator of the mean of the response variable

References


See Also

data.mme, initial.values, wmatrix, phi.mult, phi.mult.it, phi.mult.ct, prmu, prmu.time, phi.direct, phi.direct.it, phi.direct.ct, sPhikf, sPhikf.it, sPhikf.ct, modelfit1, modelfit2, modelfit3, omega, Fbetaf, Fbeta.it, Fbetaf.ct.

Examples

```r
require(Matrix)

k=3 # number of categories of the response variable
pp=c(1,1) # vector with the number of auxiliary variables in each category
data(simdata)
mod=1 # Type of model
datar=data.mme(simdata,k,pp,mod)
# # Model fit
result=modelfit1(pp, datar$Xk, datar$X, datar$Z, datar$initial, datar$y[,1:(k-1)], datar$n, datar$N)

B=1 # Bootstrap iterations
ss=12345 # SEED
set.seed(ss)

# # Bootstrap parametric BIAS and MSE
mse.pboot=mseb(pp, datar$Xk, datar$X, datar$Z, datar$n, datar$N, result, B, mod)
```
**msef**

**Analytic MSE for Model 1**

**Description**

This function calculates the analytic MSE for the multinomial mixed model with one independent random effect per category of the response variable (Model 1). See Lopez-Vizcaino et al. (2013), section 4, for details. The formulas of Prasad and Rao (1990) are adapted to Model 1. This function uses the output of *modelfit1*.

**Usage**

```r
msef(pp, X, Z, resul, MM, M)
```

**Arguments**

- `resul`: the output of the function *modelfit1*.
- `X`: list of matrices with the auxiliary variables obtained from *data.mme*. The dimension of the list is the number of categories of the response variable minus one.
- `Z`: design matrix of random effects obtained from *data.mme*.
- `pp`: vector with the number of the auxiliary variables per category.
- `M`: vector with the area sample sizes.
- `MM`: vector with the population sample sizes.

**Value**

`mse` is a matrix with the MSE estimator calculated by adapting the explicit formulas of Prasad and Rao (1990).

**References**


**See Also**

`data.mme`, `initial.values`, `wmatrix`, `phi.mult`, `prmu`, `phi.direct`, `sPhikf`, `modelfit1`, `Fbetaf`, `ci`, `mseb`.
Examples

```r
require(Matrix)

k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
data(simdata) #data
mod=1 # type of model
datar=data.mme(simdata,k,pp,mod)
# Model fit
result=modelfit3(pp,datar$xk,datar$x,datar$z,datar$initial,datar$y[,1:(k-1)],
                datar$n,datar$N)

#Analytic MSE
mse=msef(pp,datar$x,datar$z,result,datar$N,datar$n)
```

Description

This function calculates the analytic MSE for the multinomial mixed model with two independent random effects for each category of the response variable: one random effect associated with the domain and another correlated random effect associated with time and domain (Model 3). See details of the model and the expression of mse in Lopez-Vizcaino et al. (2013). The formulas of Prasad and Rao (1990) are adapted to Model 3. This function uses the output of `modelfit3`.

Usage

```r
msef.ct(p, X, result, M, MM)
```

Arguments

- `p` vector with the number of the auxiliary variables per category.
- `X` list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable minus one.
- `result` the output of the function `modelfit3`.
- `M` vector with the area sample sizes.
- `MM` vector with the population sample sizes.

Value

`mse.analitic` is a matrix with the MSE estimator calculated by adapting the explicit formulas of Prasad and Rao (1990).
References


See Also
data.mme, initial.values, wmatrix, phi.mult.ct, prmu.time, phi.direct.ct, sPhikf.ct, modelfit3, Fbetaf.ct, ci, omega, mseb.

Examples

```r
## Not run:
library(mixstock)
library(Matrix)
library(MASS)

k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
mod=3 #type of model
data(simdata3) #data
datar=data.mme(simdata3,k,pp,mod)
##Model fit
result=modelfit3(d,t,pp,datar$Xk,datar$X,datar$Z,datar$initial,datar$y[,1:(k-1)],
                   datar$n,datar$N,0)

##Analytic MSE
msef=msef.ct(pp,datar$X,result,datar$n,datar$N)
## End(Not run)
```

msef.it Analytic MSE for Model 2

Description

This function calculates the analytic MSE for the multinomial mixed model with two independent random effects for each category of the response variable: one random effect associated with the domain and another independent random effect associated with time and domain (Model 2). See details of the model and the expresion of mse in Lopez-Vizcaino et al. (2013). The formulas of Prasad and Rao (1990) are adapted to Model 2. This function uses the output of modelfit2.

Usage

`msef.it(p, X, result, M, MM)`
Arguments

- **p**: vector with the number of the auxiliary variables per category.
- **X**: list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable minus one.
- **result**: the output of the function `modelfit2`.
- **M**: vector with the area sample sizes.
- **MM**: vector with the population sample sizes.

Value

`mse.analitic` is a matrix with the MSE estimator calculated by adapting the explicit formulas of Prasad and Rao (1990). The matrix dimension is the number of domains multiplied by the number of categories minus 1.

References


See Also

`data.mme`, `initial.values`, `wmatrix`, `phi.mult.it`, `prmu.time`, `phi.direct.it`, `sPhikf.it`, `modelfit2`, `Fbetaf.it`, `ci`, `mseb`

Examples

```r
library(mixstock)
library(Matrix)

k=3 # number of categories of the response variable
pp=c(1,1) # vector with the number of auxiliary variables in each category
mod=2 # type of model
data(simdata2)
datar=data.mme(simdata2,k,pp,mod)

# Model fit
result=modelfit2(datar$d, datar$t, pp, datar$Xk, datar$X, datar$Z, datar$initial, datar$y[,1:(k-1)],
                  datar$n, datar$N)

# Analytic MSE
msef=msef.it(pp, datar$X, result, datar$n, datar$N)
```
**omega**

---

### Model correlation matrix for Model 3

**Description**

This function calculates the model correlation matrix and the first derivative of the model correlation matrix for Model 3. Model 3 is the multinomial mixed model with two independent random effects for each category of the response variable: one domain random effect and another correlated time and domain random effect.

**Usage**

omega(t, k, rho, phi)

**Arguments**

- **t**
  - number of time periods.
- **k**
  - number of categories of the response variable.
- **rho**
  - vector with the correlation parameter obtained from `modelfit3`.
- **phi**
  - vector with the values of the second variance component obtained from `modelfit3`.

**Value**

A list containing the following components.

- **Omega.d**
  - correlation matrix.
- **First.derivative.Omegad**
  - Fisher derivative of the model correlation matrix.

**References**


**See Also**

data.mme, initial.values, wmatrix, phi.mult.ct, prmu.time, phi.direct.ct, Fbeta.ct, sPhikf.ct, ci, modelfit3, msef.ct, mseb

**Examples**

```r
require(Matrix)

k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
mod=3 #type of model
```
phi.direct

Variance components for Model 1

Description

This function calculates the variance components for the multinomial mixed model with one independent random effect in each category of the response variable (Model 1). These values are used in the second part of the fitting algorithm implemented in `modelfit1`. The algorithm adapts the ideas of Schall (1991) to a multivariate model and the variance components are estimated by the REML method.

Usage

phi.direct(sigmap, phi, X, u)

Arguments

- **sigmap**: a list with the model variance-covariance matrices for each domain obtained from `wmatrix`.
- **X**: list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable minus one.
- **phi**: vector with the initial values of the variance components obtained from `modelfit1`.
- **u**: matrix with the values of the random effects obtained from `modelfit1`.

Value

A list containing the following components.

- **phi.new**: vector with the variance components.

References


See Also
data.mme, initial.values, wmatrix, phi.mult, prmu, Fbetaf, sPhikf, ci, modelfit1, msef, mseb.

Examples

```r
require(Matrix)

k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
data(simdata) #data
mod=1 #type of model
datar=data.mme(simdata,k,pp,mod)
initial=datar$initial
mean=prmu(datar$n,datar$X,initial$beta,initial$u.0)
#model variance-covariance matrix
sigmap=wmatrix(datar$n,mean$estimated.probabilities)

#Variance components
phi=phi.direct(sigmap,initial$phi.0,datar$X,initial$u.0)
```

---

**phi.direct.ct**  
Variance components for Model 3

**Description**

This function calculates the variance components for the multinomial mixed model with two independent random effects for each category of the response variable: one domain random effect and another correlated time and domain random effect (Model 3). This variance components are used in the second part of the fitting algorithm implemented in `modelfit3`. The algorithm adapts the ideas of Schall (1991) to a multivariate model. The variance components are estimated by the REML method.

**Usage**

```r
phi.direct.ct(p, sigmap, X, theta, phi1, phi2, u1, u2, rho)
```

**Arguments**

- `p`  
  vector with the number of auxiliary variables per category.

- `sigmap`  
  a list with the model variance-covariance matrices for each domain obtained from `wmatrix`.

- `X`  
  list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable minus one.
theta \quad \text{matrix with the estimated log-probabilities of each category in front of the reference category obtained from } \text{prmu.time.}

phi1 \quad \text{vector with the initial values of the first variance component obtained from } \text{modelfit3.}

phi2 \quad \text{vector with the initial values of the second variance component obtained from } \text{modelfit3.}

u1 \quad \text{matrix with the values of the first random effect obtained from } \text{modelfit3.}

u2 \quad \text{matrix with the values of the second random effect obtained from } \text{modelfit3.}

rho \quad \text{vector with the initial values of the correlation parameter obtained from } \text{modelfit3.}

\textbf{Value}

a list containing the following components.

- phi1.new \quad \text{vector with the values of the variance component for the first random effect.}
- phi2.new \quad \text{vector with the values of the variance component for the second random effect.}
- rho.new \quad \text{vector with the correlation parameter.}

\textbf{References}


\textbf{See Also}

data.mme, initial.values, wmatrix, phi.mult.ct, prmu.time, Fbetaf.ct spHikf.ct, ci, modelfit3, msef.ct, mseb, omega

\textbf{Examples}

```r
require(Matrix)

k=3 \quad \text{#number of categories of the response variable}
pp=c(1,1) \quad \text{#vector with the number of auxiliary variables in each category}
mod=3 \quad \text{#type of model}
data(simdata3) \quad \text{#data}
datar=data.mme(simdata3,k,pp,mod)
initial=datar$initial
mean=prmu.time(datar$n,datar$Xk,initial$beta.0,initial$u1.0,initial$u2.0)
sigmap=wmatrix(datar$n,mean$estimated.probabilities)

#The variance components
phi.ct=phi.direct.ct(pp,sigmap,datar$X,mean$eta,initial$phi1.0, initial$phi2.0,initial$u1.0,initial$u2.0,initial$rho.0)
```
**Description**

This function calculates the variance components for the multinomial mixed model with two independent random effects for each category of the response variable: one domain random effect and another independent time and domain random effect (Model 2). This variance components are used in the second part of the fitting algorithm implemented in `modelfit2`. The algorithm adapts the ideas of Schall (1991) to a multivariate model. The variance components are estimated by the REML method.

**Usage**

```r
phi.direct.it(pp, sigmap, x, phi1, phi2, u1, u2)
```

**Arguments**

- `pp`: vector with the number of auxiliary variables per category.
- `sigmap`: a list with the model variance-covariance matrices for each domain obtained from `wmatrix`.
- `x`: list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable.
- `phi1`: vector with the initial values of the first variance component obtained from `modelfit2`.
- `phi2`: vector with the initial values of the second variance component obtained from `modelfit2`.
- `u1`: matrix with the values of the first random effect obtained from `modelfit2`.
- `u2`: matrix with the values of the second random effect obtained from `modelfit2`.

**Value**

A list containing the following components.

- `phi1.new`: vector with the values of the variance component for the first random effect.
- `phi2.new`: vector with the values of the variance component for the second random effect.

**References**


phi.mult

Description

This function is used in initial.values to calculate the initial values for the variance components in the multinomial mixed model with one independent random effect in each category of the response variable (Model 1).

Usage

phi.mult(beta.0, y, Xk, M)

Arguments

- **beta.0**: initial values for the fixed effects obtained in initial.values.
- **y**: matrix with the response variable obtained from data.mme. The rows are the domains and the columns are the categories of the response variable.
- **Xk**: list of matrices with the auxiliary variables per category obtained from data.mme. The dimension of the list is the number of domains.
- **M**: vector with the sample size of the areas.

Value

phi.0 vector of inicial values for the variance components
References

See Also
data.mme, initial.values, wmatrix, prmu, Fbetaf, phi.direct, sPhikf, ci, modelfit1, msef, mseb.

Examples
require(Matrix)
k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
data(simdata) #data
mod=1 #type of model
data=data.mme(simdata,k,pp,mod)
###beta values
beta.new=list()
beta.new[[1]]=matrix(c( 1,3,-1),2,1)
beta.new[[2]]=matrix(c( -1.6,1),2,1)

##Initial variance components
phi=phi.mult(beta.new$data$y, data$x$k, data$y)

phi.mult.ct

Initial values for the variance components in Model 3

Description
This function is used in initial.values to calculate the initial values for the variance components in the multinomial mixed model with two independent random effects for each category of the response variable: one domain random effect and another correlated time and domain random effect (Model 3).

Usage
phi.mult.ct(beta.0, y, Xk, M, u1, u2)

Arguments
beta.0 a list with the initial values for the fixed effects per category obtained from initial.values.
y matrix with the response variable obtained from data.mme. The rows are the domains and the columns are the categories of the response variable minus one.
Xk list of matrices with the auxiliary variables per category obtained from data.mme. The dimension of the list is the number of domains.
vector with the sample size of the areas.

**u1**
matrix with the values for the first random effect obtained from `initial.values`.

**u2**
matrix with the values for the second random effect obtained from `initial.values`.

**Value**

A list containing the following components.

- **phi.0** vector of the initial values for the variance components.
- **rho.0** vector of the initial values for the correlation parameter.

**References**


**See Also**

`data.mme`, `initial.values`, `wmatrix`, `prmu.time`, `Fbetaf.ct`, `phi.direct.ct`, `sPhikf.ct`, `ci`, `modelfit3`, `msef.ct`, `omega`, `mseb`.

**Examples**

```r
require(Matrix)

k=3 # number of categories of the response variable
pp=c(1,1) # vector with the number of auxiliary variables in each category
mod=3 # type of model
data(simdataS) # data
d=nrow(simdataS)
data=datamme(simdataS,k,pp,mod)
### Fixed effects values
beta.new=list()
beta.new[[1]]=matrix(c(1,3,-1),2,1)
beta.new[[2]]=matrix(c(-1,6,1),2,1)
#### Random effects values
u1.new=rep(0.01,((k-1)*d))
dim(u1.new)=c(d,k-1)
u2.new=rep(0.01,((k-1)*d))
dim(u2.new)=c(D,k-1)

#### Initial variance components
phi=phi.mult.ct(beta.new,datar$y,datar$Xk,datar$n,u1.new,u2.new)
```
Description

This function is used in \texttt{initial.values} to calculate the initial values for the variance components in the multinomial mixed model with two independent random effects for each category of the response variable: one domain random effect (u1) and another independent time and domain random effect (u2) (Model 2).

Usage

\begin{verbatim}
phi.mult.it(beta.0, y, Xk, M, u1, u2)
\end{verbatim}

Arguments

- \texttt{beta.0} initial values for the fixed effects obtained from \texttt{initial.values}.
- \texttt{y} matrix with the response variable obtained from \texttt{data.mme}. The rows are the domains and the columns are the categories of the response variable.
- \texttt{Xk} list of matrices with the auxiliary variables per category obtained from \texttt{data.mme}. The dimension of the list is the number of domains.
- \texttt{M} vector with the sample size of the areas.
- \texttt{u1} vector with the initial values for the first random effect obtained from \texttt{initial.values}.
- \texttt{u2} vector with the initial values for the second random effect obtained from \texttt{initial.values}.

Value

\texttt{phi.0} vector of the initial values for the variance components.

References


See Also

\texttt{data.mme, initial.values, wmatrix, prmu.time, Fbeta.it, phi.direct.it, sPhikf.it, ci, modelfit2, msef.it, mseb}.

Examples

\begin{verbatim}
require(Matrix)

k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
data(simdata2) #data
mod=2 #Type of model
\end{verbatim}
print.mme

Description
This function prints objects of class mme.

Usage
## S3 method for class 'mme'
print(x, ...)

Arguments
x a list with the output of modelfit1, modelfit2 or modelfit3.

... further information.

See Also
modelfit1, modelfit2, modelfit3

Examples
k=3 # number of categories of the response variable
pp=c(1,1) # vector with the number of auxiliary variables in each category
mod=1 # Type of model
data(simdata)
datar=data.mme(simdata,k,pp,mod)
# Model fit
result=modelfit1(pp, datar$Xk, datar$X, datar$Z, datar$initial, datar$y[,1:(k-1)], datar$n, datar$N)
result
prmu

Estimated mean and probabilities for Model 1

Description

This function calculates the estimated probabilities and the estimated mean of the response variable, in the multinomial mixed model with one independent random effect in each category of the response variable (Model 1).

Usage

prmu(M, Xk, beta, u)

Arguments

- M: vector with the area sample sizes.
- Xk: list of matrices with the auxiliary variables per category obtained from `data.mme`. The dimension of the list is the number of domains.
- beta: fixed effects obtained from `modelfit1`.
- u: values of random effects obtained from `modelfit1`.

Value

A list containing the following components:

- `Estimated.probabilities`: matrix with the estimated probabilities for the categories of response variable.
- `mean`: matrix with the estimated mean of the response variable.
- `eta`: matrix with the estimated log-rates of the probabilities of each category over the reference category.

References


See Also

data.mme, initial.values, wmatrix, phi.mut, Fbetaf, phi.direct, sPhikf, ci, modelfit1, msef, mseb.
Examples

```r
require(Matrix)

k <- 3  # number of categories of the response variable
pp <- c(1, 1)  # vector with the number of auxiliary variables in each category
data(simdata)  # data
mod <- 1  # type of model
D <- nrow(simdata)
datar <- data.mme(simdata, k, pp, mod)
initial <- datar$initial

# Estimated mean and probabilities
mean <- prmu(datar$n, datar$xk, initial$beta.0, initial$u.0)
```

Description

This function calculates the estimated probabilities and the estimated mean of the response variable, in the multinomial mixed models with two independent random effects, one random effect associated with the area and the other associated with the time, for each category of the response variable. The first model assumes independent time and domain random effect (Model 2) and the second model assumes correlated time and domain random effect (Model 3).

Usage

```r
prmu.time(M, Xk, beta, u1, u2)
```

Arguments

- **M**: vector with the area sample sizes.
- **Xk**: list of matrices with the auxiliary variables per category obtained from `data.mme`. The dimension of the list is the number of domains.
- **beta**: a list with the values for the fixed effects beta per category obtained from `modelfit2`.
- **u1**: a vector with the values of the first random effect obtained from `modelfit2` or `modelfit3`.
- **u2**: a vector with the values of the second random effect obtained from `modelfit2` or `modelfit3`.

Value

A list containing the following components:

- **Estimated.probabilities**: matrix with the estimated probabilities for the categories of response variable.
- **mean**: matrix with the estimated mean of the response variable.
- **eta**: matrix with the estimated log-rates of the probabilities of each category over the reference category.
References


See Also

data.mme, initial.values, wmatrix, phi.mult.it, Fbeta.it, phi.direct.it, sPhikf.it, ci, modelfit2, msef.it, mseb

Examples

require(Matrix)

k=3 # number of categories of the response variable
pp=c(1,1) # vector with the number of auxiliary variables in each category
mod=2 # Type of model
data(simdata2) # data
datar=data.mme(simdata2,k,pp,mod)
initial=datar$initial

## Estimated mean and estimated probabilities
mean=prmu.time(datar$n,datar$xk,initial$beta.0,initial$u1.0,initial$u2.0)

### Dataset for Model 1

Dataset used by the multinomial mixed effects model with one independent random effect in each category of the response variable (Model 1). This dataset contains 15 small areas. The response variable has three categories. The last is the reference category. The variables are as follows:

Format

A data frame with 15 rows and 9 variables in columns

Details

- area: area indicator.
- Time: time indicator.
- sample: the sample size of each domain.
- Population: the population size of each domain.
- Y1: the first category of the response variable.
- Y2: the second category of the response variable.
- Y3: the third category of the response variable.
- X1: the covariate for the first category of the response variable.
- X2: the covariate for the second category of the response variable.
Examples

```r
require(Matrix)

k=3 # number of categories of the response variable
pp=c(1,1) # vector with the number of auxiliary variables in each category
data(simdata) # data
mod=1 # type of model
datar=data.mme(simdata,k,pp,mod)
# Model fit
result=model(datar$d,datar$t,pp,datar$Xk,datar$X,datar$Z,datar$initial,datar$y[,1:(k-1)],
datar$n,datar$N,mod)

# Analytic MSE
mse=msef(pp,datar$X,datar$Z,result,datar$N,datar$n)

B=1 # Bootstrap iterations
ss=12345 # SEED
set.seed(ss)

# Bootstrap parametric BIAS and MSE
mse.pboot=mseb(pp,datar$Xk,datar$X,datar$Z,datar$n,datar$N,result,B,mod)
```

---

**simdata2**

*Dataset for Model 2*

Description

Dataset used by the multonomial mixed effects model with two independent random effects in each category of the response variable: one domain random effect and another independent time and domain random effect (Model 2). This dataset contains 10 small areas and two periods. The response variable has three categories. The last is the reference category. The variables are as follows:

**Format**

A data frame with 30 rows and 9 variables in columns

**Details**

- area: area indicator.
- Time: time indicator.
- sample: the sample size of each domain.
- Population: the population size of each domain.
- Y1: the first category of the response variable.
- Y2: the second category of the response variable.
- Y3: the third category of the response variable.
- X1: the covariate for the first category of the response variable.
- X2: the covariate for the second category of the response variable.
Examples

```r
library(mixstock)
library(Matrix)

k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
data(simdata2)
mod=2 #type of model
datar=data.mme(simdata2,k,pp,mod)

##Model fit
result=model(datar$d,datar$t,pp,datar$Xk,datar$X,datar$Z,datar$initial,datar$y[,1:(k-1)],
datar$n,datar$N,mod)

##Analytic mse
msef=msef.it(pp,datar$X,result,datar$n,datar$N)

B=1  #Bootstrap iterations
ss=12345 #SEED
set.seed(ss)

##Bootstrap parametric BIAS and MSE
mse.pboot=mseb(pp,datar$Xk,datar$X,datar$Z,datar$n,datar$N,result,B,mod)
```

---

**simdata3**  
*Dataset for Model 3*

**Description**

Dataset used by the multinomial mixed effects model with two independent random effects in each category of the response variable: one domain random effect and another correlated time and domain random effect (Model 3). This dataset contains ten small areas and four periods. The response variable has three categories. The last is the reference category. The variables are as follows:

**Format**

A data frame with 40 rows and 9 variables in columns

**Details**

- area: area indicator.
- Time: time indicator.
- sample: the sample size of each domain.
- Population: the population size of each domain.
- Y1: the first category of the response variable.
- Y2: the second category of the response variable.
• Y3: the third category of the response variable.
• X1: the covariate for the first category of the response variable.
• X2: the covariate for the second category of the response variable.

Examples

```r
## Not run:
library(mixstock)
library(Matrix)
library(MASS)

k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
mod=3 #type of model
data(simdata3) #data
datar=data.mme(simdata3,k,pp,mod)
##Model fit
result=model(datar$d,datar$t,pp,datar$Xk,datar$X,datar$Z,datar$initial,datar$y[,1:(k-1)],
datar$n,datar$N,mod)

##Analytic MSE
msef=msef.ct(pp,datar$X,result,datar$n,datar$N)

B=1000 #Bootstrap iterations
ss=12345 #SEED
set.seed(ss)

##Bootstrap parametric BIAS and MSE
mse.pboot=mseb(pp,datar$Xk,datar$X,datar$Z,datar$n,datar$N,result,B,mod)
## End(Not run)
```

**sPhikf**

Fisher information matrix and score vectors of the variance components for Model 1

Description

This function computes the Fisher information matrix and the score vectors of the variance components, for the multinomial mixed model with one independent random effect in each category of the response variable (Model 1). These values are used in the fitting algorithm implemented in `modelfit1` to estimate the random effects. The algorithm adapts the ideas of Schall (1991) to a multivariate model. The variance components are estimated by the REML method.

Usage

```r
sPhikf(pp, sigmap, X, eta, phi)
```
Arguments

pp vector with the number of the auxiliary variables per category.
sigmap a list with the model variance-covariance matrices for each domain obtained from \texttt{wmatrix}.
\(X\) list of matrices with the auxiliary variables obtained from \texttt{data.mme}. The dimension of the list is the number of categories of the response variable minus one.
\(\eta\) matrix with the estimated log-rates of probabilities of each category over the reference category obtained from \texttt{prmu}.
\(\phi\) vector with the values of the variance components obtained from \texttt{modelfit1}.

Value

A list containing the following components.

\(S_k\) phi score vector.
\(F\) Fisher information matrix of the variance component \(\phi\).

References


See Also

\texttt{data.mme}, \texttt{initial.values}, \texttt{wmatrix}, \texttt{phi.mult}, \texttt{prmu}, \texttt{phi.direct}, \texttt{Fbetaf}, \texttt{ci}, \texttt{modelfit1}, \texttt{msef}, \texttt{mseb}.

Examples

```r
require(Matrix)
k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
data(simdata) #data
mod=1 #type of model
datar=data.mme(simdata,k,pp, mod)
initial=datar$initial
mean=prmu(datar$n,datar$Xk,initial$beta.0,initial$u.0)
sigmap=wmatrix(datar$n,mean$estimated.probabilities)

#Fisher information matrix and score vectors
Fisher.phi=sPhikf(pp,sigmap,datar$X,mean$eta,initial$phi.0)
```
Description

This function computes the Fisher information matrix and the score vectors of the variance components, for the multinomial mixed model with two independent random effects for each category of the response variable: one domain random effect and another correlated time and domain random effect (Model 3). These values are used in the fitting algorithm implemented in `modelfit3` to estimate the random effects. The algorithm adapts the ideas of Schall (1991) to a multivariate model. The variance components are estimated by the REML method.

Usage

`sPhikf.ct(d, t, pp, sigmap, X, eta, phi1, phi2, rho, pr, M)`

Arguments

d  number of areas.
t  number of time periods.
pp  vector with the number of the auxiliary variables per category.
sigmap  a list with the model variance-covariance matrices for each domain obtained from `wmatrix`.
X  list of matrices with the auxiliary variables obtained from `data.mme`. The dimension of the list is the number of categories of the response variable minus one.
eta  matrix with the estimated log-rates of probabilities of each category over the reference category obtained from `prmu.time`.
phi1  vector with the values of the first variance component obtained from `modelfit3`.
phi2  vector with the values of the second variance component obtained from `modelfit3`.
rho  vector with the correlation parameter obtained from `modelfit3`.
pr  matrix with the estimated probabilities of the response variable obtained from `prmu.time`.
M  vector with the area sample sizes.

Value

A list containing the following components.

S  (phi1, phi2, rho) score vector.
F  Fisher information matrix of the variance components (phi1, phi2, rho).
References


See Also
data.mme, initial.values, wmatrix, phi.mult.ct, prmu.time, phi.direct.ct, Fbetaf.ct, omega.ci, modelfit3, msef.ct.mseb

Examples

require(Matrix)

k=3 #number of categories of the response variable
pp=c(1,1) #vector with the number of auxiliary variables in each category
mod=3 #type of model
data(simdata3) #data
datar=data.mme(simdata3,k,pp, mod)
initial=datar$initial
mean=prmu.time(datar$n,datar$Xk,initial$beta.0,initial$u1.0,initial$u2.0)
sigmap=wmatrix(datar$n,mean$estimated.probabilities)

## Fisher information matrix and the score vectors
Fisher.phi_ct=sPhikf.ct(datar$d,datar$t,pp,sigmap,datar$X,mean$eta,initial$phi1.0,
initial$phi2.0,initial$rho.0,mean$estimated.probabilities,datar$n)

Description

This function computes the Fisher information matrix and the score vectors of the variance components, for the multinomial mixed model with two independent random effects for each category of the response variable: one domain random effect and another independent time and domain random effect (Model 2). These values are used in the fitting algorithm implemented in modelfit2 to estimate the random effects. The algorithm adapts the ideas of Schall (1991) to a multivariate model. The variance components are estimated by the REML method.

Usage

sPhikf.it(d, t, pp, sigmap, X, eta, phi1, phi2)
Arguments

d
number of areas.

t
number of time periods.

pp
vector with the number of the auxiliary variables per category.

sigmap
a list with the model variance-covariance matrices for each domain obtained from \texttt{wmatrix}.

X
list of matrices with the auxiliary variables obtained from \texttt{data.mme}. The dimension of the list is the number of categories of the response variable minus one.

eta
matrix with the estimated log-rates of probabilities of each category over the reference category obtained from \texttt{prmu.time}.

phi1
vector with the values of the first variance component obtained from \texttt{modelfit2}.

phi2
vector with the values of the second variance component obtained from \texttt{modelfit2}.

Value

A list containing the following components.

S
phi score vector.

F
Fisher information matrix of the variance components phi1 and phi2.

References


See Also

data.mme, initial.values, wmatrix, phi.mult.it, prmu.time, phi.direct.it, Fbetaf.it, ci, modelfit2, msef.it, mseb

Examples

\begin{verbatim}
require(Matrix)
k=3 # number of categories of the response variable pp=c(1,1) # vector with the number of auxiliary variables in each category mod=2 # Type of model data(simdata2) # data datar=data.mme(simdata2,k,pp,mod) initial=datar$initial mean=prmu.time(datar$n,datar$XK,initial$beta.0,initial$u1.0,initial$u2.0) sigmap=wmatrix(datar$n,mean$estimated.probabilities)
\end{verbatim}
wmatrix

## Fisher information matrix and score vectors
Fisher.phi=sPhikf.it(datar$d, datar$t, pp, sigmap, datar$X, mean$eta, initial$phi1.0, initial$phi2.0)

### wmatrix

#### Model variance-covariance matrix of the multinomial mixed models

**Description**

This function calculates the variance-covariance matrix of the multinomial mixed models. Three types of multinomial mixed model are considered. The first model (Model 1), with one random effect in each category of the response variable; Model 2, introducing independent time effect; Model 3, introducing correlated time effect.

**Usage**

```r
wmatrix(M, pr)
```

**Arguments**

- `M` vector with area sample sizes.
- `pr` matrix with the estimated probabilities for the categories of the response variable obtained from `prmu` or `prmu.time`.

**Value**

`W` a list with the model variance-covariance matrices for each domain.

**References**


**See Also**

data.mme, initial.values, phi.mutl, prmu, prmu.time, Fbetaf, phi.direct, sPhikf, ci, modelfit1, msef, mseb

**Examples**

```r
require(Matrix)
k=3 # number of categories of the response variable
pp=c(1,1) # vector with the number of auxiliary variables in each category
mod=2 # type of model
data(simdata2)
datar=data.mme(simdata2, k, pp, mod)
initial=datar$initial
mean=prmu.time(datar$n, datar$X, initial$beta.0, initial$u1.0, initial$u2.0)
```
The model variance-covariance matrix

varcov = wmatrix(datar$n, mean$estimated.probabilities)
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