

Package ‘pedigreemm’

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Title Pedigree-Based Mixed-Effects Models

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Description Fit pedigree-based mixed-effects models.

Depends R(>= 3.0.0), lme4 (>= 1.0), Matrix (>= 1.0), methods

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LazyData yes

License GPL (>= 2)

URL <https://github.com/anainesvs/pedigreemm/>

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R topics documented:

Dmat	2
editPed	2
getA	4
getAInv	4
inbreeding	5
mastitis	6
milk	7
pedCows	8
pedCowsR	9
pedigree	9
pedigree-class	10
pedigreemm	11
pedigreemm-class	13
pedSires	14
relfactor	15

Index**16**

Dmat	<i>vector of the diagonal for the D matrix from the decomposition $A = TDT'$</i>
------	---

Description

numeric vector that should be the diagonal elements of the diagonal matrix D

Usage

```
Dmat(ped)
```

Arguments

ped an object that inherits from class [pedigree](#)

Details

Determine the diagonal factor in the decomposition of the relationship matrix from a pedigree equal to TDT' . Where T is unit lower triangular and D is a diagonal matrix. This function returns a numeric vector with the entries of D

Value

a numeric vector

Examples

```
ped <- pedigree(sire = c(NA,NA,1, 1,4,5),
               dam   = c(NA,NA,2,NA,3,2), label= 1:6)
Dmat(ped)
```

editPed	<i>Complete and Order a Pedigree</i>
---------	--------------------------------------

Description

This function helps to prepare a pedigree to generate a pedigree object

Usage

```
editPed(sire, dam, label, verbose)
```

Arguments

sire	a vector (with some NA entries) with the father IDs
dam	similarly as sire for the “mother” of each entry. The vector must be of the same length than the one for the sire
label	a vector with the subjects id. Giving a unique ID for the corresponding entry. The length as sire and dam should be the same
verbose	logical entry inquiring whether to print line that the program is evaluating. The default is FALSE.

Details

The function takes a vector of sires, another for dams and a final one for subjects all of the same length, convert them to character. If there are dams or sires not declared as subjects the function generates them. Finally, it orders the pedigree. The output can be used to build a pedigree object ped

Value

A data frame with strings as characters. All subjects are in the label column, and all subjects will appear in this column before appearing as sires or dams.

Examples

```
#(1)
pede<-data.frame(sire=as.character(c(NA,NA,NA,NA,NA,1,3,5,6,4,8,1,10,8)),
                 dam= as.character(c(NA,NA,NA,NA,NA,2,2,NA,7,7,NA,9,9,13)),
                 label=as.character(1:14))
#scrambled original pedigree:
(pede<- pede[sample(replace=FALSE, 1:14),] )
(pede<- editPed(sire=pede$sire, dam= pede$dam, label=pede$label))
ped<- with(pede, pedigree(label=label, sire=sire, dam=dam))
#####
#(2) With missing labels
pede<-data.frame(sire=as.character(c(NA,1,3,5,6,4,8,1,10,8)),
                 dam= as.character(c(NA,2,2,NA,7,7,NA,9,9,13)),
                 label=as.character(5:14))
#scrambled original pedigree:
(pede<- pede[sample(replace=FALSE, 1:10),] )
(pede<- editPed(sire=pede$sire, dam= pede$dam, label=pede$label))
ped<- with(pede, pedigree(label=label, sire=sire, dam=dam))

#####
#(2) A larger pedigree
#Useing pedCows pedigree
# str(pedCows)
# pede<-data.frame(id=pedCows@label, sire=pedCows@sire, dam=pedCows@dam)
# pede<-pede[sample(1:nrow(pede),replace=FALSE),]
# pede<- editPed(sire=pede$sire, dam=pede$dam, label=pede$id)
# ped<- with(pede, pedigree(label=label, sire=sire, dam=dam))
```

getA *Additive Relationship Matrix*

Description

Additive relationship matrix from a pedigree

Usage

```
getA(ped)
```

Arguments

ped a pedigree that includes the individuals who occur in labs

Details

Returns the additive relationship matrix for the pedigree ped .

Value

Sparse matrix

Examples

```
## Example from chapter 2 of Mrode (2005)

ped <- pedigree(sire = c(NA,NA,1, 1,4,5),
               dam  = c(NA,NA,2,NA,3,2), label= 1:6)

(getA(ped))
```

getAInv *Inverse of the relationship matrix*

Description

Inverse of the Relationship matrix from a pedigree

Usage

```
getAInv(ped)
```

Arguments

ped a pedigree that includes the individuals who occur in labs

Details

Determine the inverse of the relationship matrix from a pedigree ped.

Value

sparse matrix, inverse of the relationship matrix

References

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. *Journal of Animal Science*, 88:497-504.

Examples

```
## Example from chapter 2 of Mrode (2005)
ped <- pedigree(sire = c(NA,NA,1, 1,4,5),
               dam  = c(NA,NA,2,NA,3,2), label= 1:6)
getAInv(ped)
```

inbreeding	<i>Inbreeding coefficients from a pedigree...</i>
------------	---

Description

Inbreeding coefficients from a pedigree

Usage

```
inbreeding(ped)
```

Arguments

ped an object that inherits from class [pedigree](#)

Details

Determine the inbreeding coefficients for all the individuals of a pedigree. This function a numeric vector.

Value

a numeric vector

Source

Sargolzaei, M. and H. Iwaisaki, 2005. Comparison of four direct algorithms for computing the inbreeding coefficients. *J. Anim. Sci*, 76: 401-406.

References

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. *Journal of Animal Science*, 88:497-504.

Examples

```
ped <- pedigree(sire = c(NA,NA,1, 1,4,5),
               dam  = c(NA,NA,2,NA,3,2), label= 1:6)
inbreeding(ped)
```

 mastitis

Mastitis cases in dairy cattle

Description

Records of the number of cases of clinical mastitis during the first lactation of 1,675 cows, primarily Holsteins. Cows belonged to 41 herds and were daughters of 38 sires. There were 1,491 healthy cows, 134 had only one case of mastitis, 36 had 2 cases, and 14 had between 4 and cases. Overall, mastitis incidence was 0.11. Calving years for these records were from 2000 through 2005. The sire, herd and days in milk are also recorded for each cow.

Format

A data frame with 1675 observations on the following 8 variables.

id Identifier of the animal.

sire Identifier of the animal's sire.

birth year of birth of the animal (as a factor).

herd herd id number (as a factor).

calvingYear year of calving for this lactation.

DIM total number of days in milk for the lactation.

mastitis a factor indicating if the cow had any incidents of clinical mastitis during the lactation.

NCM An ordered factor giving the number of clinical mastitis cases for the cow during this lactation.

Details

The pedigree of the sires is given in the companion [pedSires](#) data set.

Source

Vazquez, A.I. 2007. Analysis of number of episodes of clinical mastitis in Norwegian Red and Holstein cows with Poisson and categorical data mixed models. Master of Science Thesis. University of Wisconsin - Madison. 162 pp.

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. Journal of Animal Science, 88:497-504.

References

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. Journal of Animal Science, 88:497-504.

See Also

[pedSires](#), [pedigree](#)

Examples

```
str(mastitis)
summary(mastitis, maxsum = 10)
```

milk

Milk production

Description

Records of the milk production of 3397 lactations from first through fifty parity Holsteins. These were 1,359 cows, daughters of 38 sires in 57 herds. The data was downloaded from the USDA internet site. All lactation records represent cows with at least 100 days in milk, with an average of 347 days. Milk yield ranged from 4,065 to 19,345 kg estimated for 305 days, averaging 11,636 kg. There were 1,314, 1,006, 640, 334 and 103 records were from first thorough fifth lactation animals.

Format

A data frame with 3397 observations on the following 9 variables.

id numeric identifier of cow

lact number of lactation for which production is measured

herd a factor indicating the herd

sire a factor indicating the sire

dim number of days in milk for that lactation

milk milk production estimated at 305 days

fat fat production estimated at 305 days

prot protein production estimated at 305 days

scs the somatic cell score

Source

USDA web site. <http://www.aipl.arsusda.gov/>

References

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. *Journal of Animal Science*, 88:497-504.

Examples

```
str(milk)
```

pedCows

Pedigree of the cows in milk

Description

A [pedigree](#) object giving (part of) the pedigree of the cows in the [milk](#) data frame.

Format

The format is: Formal class 'pedigree' [package "pedigreemm"] with 3 slots ..@ sire : int [1:6547]
 NA NA NA NA NA NA NA NA NA NA@ dam : int [1:6547] NA NA NA NA NA NA NA NA NA
 NA NA@ label: chr [1:6547] "1" "2" "3" "4" ...

References

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. *Journal of Animal Science*, 88:497-504.

See Also

[milk](#)

Examples

```
str(pedCows)
```

pedCowsR	<i>Pedigree of the cows in milk with 0.70 of the information in pedCows</i>
----------	---

Description

A [pedigree](#) object giving (part of) the pedigree of the cows in the [milk](#) data frame. This pedigree allows the example with 'milk' to run faster.

Format

The format is: Formal class 'pedigree' [package "pedigreemm"] with 3 slots ..@ sire : int [1:6547] NA NA NA NA NA NA NA NA NA NA NA@ dam : int [1:6547] NA NA NA NA NA NA NA NA NA NA NA@ label: chr [1:6547] "1" "2" "3" "4" ...

References

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. *Journal of Animal Science*, 88:497-504.

See Also

[milk](#)

Examples

```
str(pedCowsR)
```

pedigree	<i>Pedigree Constructor</i>
----------	-----------------------------

Description

Construct an object of class "pedigree", more conveniently than by `new("pedigree", ...)`.

Usage

```
pedigree(sire, dam, label)
```

Arguments

sire	numeric vector (with some NA entries) of integer IDs, denoting a <i>previous</i> entry in the pedigree corresponding to the current entry's "father".
dam	similarly as sire for the "mother" of each entry.
label	a vector coercable to "character" of the same length as sire and dam giving a unique ID for the corresponding entry.

Value

an object of formal class "[pedigree](#)".

References

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. *Journal of Animal Science*, 88:497-504.

See Also

the [pedigree](#) class.

Examples

```
example("pedigree-class") ## 'p1' pedigree object `the hard way'

ped <- pedigree(sire = c(NA,NA,1, 1,4,5),
               dam  = c(NA,NA,2,NA,3,2), label= 1:6)
## note that 'label' is coerced to character automatically
ped
stopifnot(identical(ped, p1))
```

pedigree-class	<i>Class "pedigree"</i>
----------------	-------------------------

Description

Objects of class "pedigree" represent a set of individuals that can have two parents including their parent-child relations. The terminology has been taken from cattle breeding. The "pedinbred" class is an extension of the pedigree class with an additional slot of the inbreeding coefficients.

Objects from the Class

Objects in the "pedigree" class can be created by calls of the form `new("pedigree", ...)`, or more conveniently, `pedigree(sire=., dam=., label=.)`.

Objects of the "pedinbred" class are created by coercing a pedigree to class "pedinbred".

Slots

sire: integer vector (with some NA entries), denoting a *previous* entry in the pedigree corresponding to the current entry's "father".

dam: similarly as sire for the "mother" of each entry.

label: a "character" vector of the same length as sire and dam giving a unique ID for the corresponding entry.

F: (class "pedinbred" only) a numeric vector of inbreeding coefficients.

Methods

coerce signature(from = "pedigree", to = "sparseMatrix"): returns a sparse, unit lower-triangular matrix which is the inverse of the "L" part of the "LDL'" form of the Cholesky factorization of the relationship matrix. All non-zero elements below the diagonal are -0.5.

coerce signature(from = "pedigree", to = "data.frame"): ...

head signature(x = "pedigree"): ...

show signature(object = "pedigree"): ...

tail signature(x = "pedigree"): ...

References

R. A. Mrode, *Linear Models for the Prediction of Animal Breeding Values*, 2nd ed, CABI Publishing, 2005.

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. *Journal of Animal Science*, 88:497-504.

See Also

[pedigree](#), [inbreeding](#)

Examples

```
## Rather use, pedigree()! The following is "raw code":
## Example from chapter 2 of Mrode (2005)
p1 <- new("pedigree",
         sire = as.integer(c(NA,NA,1, 1,4,5)),
         dam  = as.integer(c(NA,NA,2,NA,3,2)),
         label = as.character(1:6))

p1
(dtc <- as(p1, "sparseMatrix")) # T-inverse in Mrode's notation
solve(dtc)
inbreeding(p1)
```

pedigreemm

Fit mixed-effects models incorporating pedigrees

Description

Fit linear or generalized linear mixed models incorporating the effects of a pedigree.

Usage

```
pedigreemm(formula, data, family = NULL, REML = TRUE,
           pedigree = list(), control = list(),
           start = NULL, verbose = FALSE, subset, weights,
           na.action, offset, contrasts = NULL, model = TRUE,
           x = TRUE, ...)
```

Arguments

pedigree	a named list of pedigree objects. The names must correspond to the names of grouping factors for random-effects terms in the formula argument.
formula	as in lmer
data	as in lmer
family	as in glmer
REML	as in lmer
control	as in lmer
start	as in lmer
verbose	as in lmer
subset	as in lmer
weights	as in lmer
na.action	as in lmer
offset	as in lmer
contrasts	as in lmer
model	as in lmer
x	as in lmer
...	as in lmer

Details

All arguments to this function are the same as those to the function [lmer](#) except pedigree which must be a named list of [pedigree](#) objects. Each name (frequently there is only one) must correspond to the name of a grouping factor in a random-effects term in the formula. The observed levels of that factor must be contained in the pedigree. For each pedigree the (left) Cholesky factor of the relationship matrix restricted to the observed levels is calculated using [relfactor](#) and applied to the model matrix for that term.

Value

a [pedigreemm](#) object.

References

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. *Journal of Animal Science*, 88:497-504.

See Also

[pedigreemm](#), [pedigree](#), [relfactor](#).

Examples

```

p1 <- new("pedigree",
        sire = as.integer(c(NA,NA,1, 1,4,5)),
        dam  = as.integer(c(NA,NA,2,NA,3,2)),
        label = as.character(1:6))
A<-getA(p1)
cholA<-chol(A)
varU<-0.4; varE<-0.6; rep<-20
n<-rep*6
set.seed(108)
bStar<- rnorm(6, sd=sqrt(varU))
b<-crossprod(as.matrix(cholA),bStar)
ID <- rep(1:6, each=rep)
e0<-rnorm(n, sd=sqrt(varE))
y<-b[ID]+e0
fm1 <- pedigreemm(y ~ (1|ID) , pedigree = list(ID = p1))
table(y01<-ifelse(y<1.3,0,1))
fm2 <- pedigreemm(y01 ~ (1|ID) , pedigree = list(ID = p1), family = 'binomial')

```

pedigreemm-class

Pedigree-based mixed-effects model fits

Description

A mixed-effects model fit by `pedigreemm`. This class extends class `"merMod"` class and includes one additional slot, `relfac`, which is a list of (left) Cholesky factors of the relationship matrices derived from `"pedigree"` objects.

Objects from the Class

Objects are created by calls to the `pedigreemm` function.

Slots

`relfac`: A list of relationship matrix factors. All other slots are inherited from class `"merMod"`.

Extends

Class `"merMod"`, directly.

Methods

fitted signature(object = "pedigreemm"): actually a non-method in that `fitted` doesn't apply to such objects because of the pre-whitening.

ranef signature(object = "pedigreemm"): incorporates the pedigree into the random effects as returned for the object viewed as a `"merMod"` object.

residuals signature(object = "pedigreemm"): also a non-method for the same reason as `fitted`

See Also[pedigreemm](#)**Examples**

```
showClass("pedigreemm")
```

pedSires	<i>Pedigree of the sires from mastitis</i>
----------	--

Description

A [pedigree](#) object giving (part of) the pedigree of the sires from the [mastitis](#) data frame. The pedigree is traced back on sires only.

Format

The format is: Formal class 'pedigree' [package "pedigreemm"] with 3 slots ..@ sire : int [1:352] NA NA NA NA NA NA NA NA NA NA NA@ dam : int [1:352] NA NA NA NA NA NA NA NA NA NA NA@ label: chr [1:352] "1" "2" "3" "4" ...

References

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. *Journal of Animal Science*, 88:497-504.

See Also[mastitis](#)**Examples**

```
str(pedSires)
```

relfactor	<i>Relationship factor from a pedigree...</i>
-----------	---

Description

Relationship factor from a pedigree

Usage

```
relfactor(ped, labs)
```

Arguments

ped	a pedigree that includes the individuals who occur in labs
labs	a character vector or a factor giving the labels to which to restrict the relationship matrix. If labs is a factor then the levels of the factor are used as the labels. Default is the complete set of labels in the pedigree.

Details

Determine the right Cholesky factor of the relationship matrix for the pedigree ped, possibly restricted to the specific labels that occur in labs.

Value

an upper triangular, sparse (right) Cholesky factor of the relationship matrix

References

2010. A.I. Vazquez, D.M. Bates, G.J.M. Rosa, D. Gianola and K.A. Weigel. Technical Note: An R package for fitting generalized linear mixed models in animal breeding. *Journal of Animal Science*, 88:497-504.

Examples

```
## Example from chapter 2 of Mrode (2005)

ped <- pedigree(sire = c(NA,NA,1, 1,4,5),
               dam  = c(NA,NA,2,NA,3,2), label= 1:6)
(fac <- relfactor(ped))
crossprod(fac)  # the relationship matrix
getA(ped)      # the relationship matrix
```

Index

- * **algebra**
 - editPed, 2
 - getA, 4
 - getAInv, 4
 - relfactor, 15
- * **array**
 - editPed, 2
 - getA, 4
 - getAInv, 4
 - relfactor, 15
- * **classes**
 - pedigree-class, 10
 - pedigreemm-class, 13
- * **datasets**
 - mastitis, 6
 - milk, 7
 - pedCows, 8
 - pedCowsR, 9
 - pedSires, 14
- * **misc**
 - Dmat, 2
 - inbreeding, 5
 - pedigree, 9
- * **models**
 - pedigreemm, 11
- coerce, pedigree, data.frame-method
(pedigree-class), 10
- coerce, pedigree, sparseMatrix-method
(pedigree-class), 10
- Dmat, 2
- editPed, 2
- fitted, pedigreemm-method
(pedigreemm-class), 13
- getA, 4
- getAInv, 4
- glmer, 12
- head, pedigree-method (pedigree-class),
10
- inbreeding, 5, 11
- lmer, 12
- mastitis, 6, 14
- merMod, 13
- milk, 7, 8, 9
- pedCows, 8
- pedCowsR, 9
- pedigree, 2, 5, 7–9, 9, 10–14
- pedigree-class, 10
- pedigreemm, 11, 12–14
- pedigreemm-class, 13
- pedinbred-class (pedigree-class), 10
- pedSires, 6, 7, 14
- ranef, pedigreemm-method
(pedigreemm-class), 13
- relfactor, 12, 15
- residuals, pedigreemm-method
(pedigreemm-class), 13
- show, pedigree-method (pedigree-class),
10
- tail, pedigree-method (pedigree-class),
10