

Package ‘INLAtools’

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Type Package

Title Functionalities for the 'INLA' Package

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Description Contain code to work with latent Gaussian Markov random field (GMRF) models. Queries for the 'cgeneric' interface, specified as a way to implement new GMRF models to be fitted as model components in the 'INLA' package (<<https://www.r-inla.org>>). The implemented functionalities leverage the use of 'cgeneric' models and provide a way to debug the code as well to work with the prior for the model parameters and to sample from it. A Kronecker product method is also implemented to work with the four possible combinations between a 'cgeneric' and a 'rgeneric' model.

Additional_repositories <https://inla.r-inla-download.org/R/testing>

License GPL (>= 2)

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cgeneric	<i>Defines a GMRF model to be used with the C interface for INLA as a latent model.</i>
----------	---

Description

This prepare data for the C type to organize data needed for building latent models which are characterized from given model parameters θ and the the following model elements.

- graph to define the non-zero precision matrix pattern. only the upper triangle including the diagonal is needed. The order should be by line.
- Q vector where the
 - first element (N) is the size of the matrix,
 - second element (M) is the number of non-zero elements in the upper part (including) diagonal
 - the remaining (M) elements are the actual precision (upper triangle plus diagonal) elements whose order shall follow the graph definition.
- mu the mean vector,
- initial vector with
 - first element as the number of the parameters in the model
 - remaining elements should be the initials for the model parameters.
- log.norm.const log of the normalizing constant.
- log.prior log of the prior for the model parameters.

See details in [INLA::cgeneric\(\)](#)

Usage

```
cgeneric(model, ...)
```

Arguments

model	object class for what a cgeneric method exists. if it is a character, a specific function will be called, for example <code>cgeneric("iid", ...)</code> calls <code>cgeneric_iid(...)</code> , see <code>cgeneric_iid()</code> and <code>cgeneric_generic0()</code> .
...	additional arguments passed on to methods

Value

named list of cgeneric class containing the named list `f` that contain `model` (a character always equal to `cgeneric`), `n` (integer) and `cgeneric` as a named list that contains the data needed to define the model. Each element on `...$fcgeneric` is also a named list containing ints, doubles, characters, matrices and smatrices.

See Also

`INLA::cgeneric()` and `methods()`

cgeneric-class	<i>The cgeneric class for <code>cgeneric()</code>.</i>
----------------	--

Description

The cgeneric class for `cgeneric()`.

Usage

```
## S3 method for class 'character'
cgeneric(
  model,
  debug = FALSE,
  package,
  useINLApcomp = TRUE,
  libpath = NULL,
  ...
)

cgeneric_libpath(fName, package, useINLApcomp = FALSE, debug = FALSE)
```

Arguments

model	object class for what a cgeneric method exists. E.g., if it is a character, a specific function will be called: cgeneric("iid", ...) calls cgeneric_iid(...)
debug	integer, used as verbose in debug.
package	character giving the name of the package that contains the cgeneric model.
useINLAprecomp	logical, indicating if it is to use the shared object previously copied and compiled by INLA.
libpath	character, to inform the full path to the shared dynamic library object (this override the arguments useINLAprecomp and package).
...	additional arguments passed to to methods. Some arguments can be used to define specific behavior, such as debug (integer, used as verbose in debug), useINLAprecomp (logical, indicating if it is to use the shared object previously copied and compiled by INLA), package (character used if useINLAprecomp is TRUE, with the package name to build the path) and libpath (character, with the path to the shared dynamic library object: this override useINLAprecomp and package).
fName	character with the name of the function used to build the cgeneric model.

Details

Method for when model is a character. E.g. cgeneric(model = "generic0") calls [cgeneric_generic0](#)

Value

character containing the path to the shared lib

Functions

- cgeneric(character): This calls [INLA::inla.cgeneric.define\(\)](#)
- cgeneric_libpath(): Get the shared lib path to use in a cgeneric model

cgeneric_generic0	<i>Build an cgeneric object for a generic0 model. See details.</i>
-------------------	--

Description

Build data needed to implement a model whose precision has a conditional precision parameter. This uses the C interface in the 'INLA' package, that can be used as a linear predictor model component with an 'f' term.

Usage

```
cgeneric_generic0(R, param, constr = TRUE, scale = TRUE, ...)
```

```
cgeneric_iid(n, param, constr = FALSE, ...)
```

Arguments

<code>R</code>	the structure matrix for the model definition.
<code>param</code>	length two vector with the parameters a and p for the PC-prior distribution defined from $P(\sigma > a) = p$ where σ can be interpreted as marginal standard deviation of the process if <code>scale = TRUE</code> . See details.
<code>constr</code>	logical indicating if it is to add a sum-to-zero constraint. Default is <code>TRUE</code> .
<code>scale</code>	logical indicating if it is to scale the model. See details.
<code>...</code>	arguments (<code>debug</code> , <code>useINLAprecomp</code> , <code>libpath</code>) passed on to <code>cgeneric()</code> .
<code>n</code>	integer required to specify the model size

Details

The precision matrix is defined as

$$Q = \tau R$$

where the structure matrix R is supplied by the user and τ is the precision parameter. Following Sørbye and Rue (2014), if `scale = TRUE` the model is scaled so that

$$Q = \tau s R$$

where s is the geometric mean of the diagonal elements of the generalized inverse of R .

$$s = \exp \sum_i \log((R^-)_{ii})/n$$

If the model is scaled, the geometric mean of the marginal variances, the diagonal of Q^{-1} , is one. Therefore, when the model is scaled, τ is the marginal precision, otherwise τ is the conditional precision.

Value

a `cgeneric` object, see `cgeneric()`.

Functions

- `cgeneric_iid()`: The `cgeneric_iid` uses the `cgeneric_generic0` with the structure matrix as the identity.

References

Sigrunn Holbek Sørbye and Håvard Rue (2014). Scaling intrinsic Gaussian Markov random field priors in spatial modelling. *Spatial Statistics*, vol. 8, p. 39-51.

See Also

`prior.cgeneric()`

Examples

```
## structured precision matrix model definition
R <- Matrix(toeplitz(c(2,-1,0,0,0)))
R
mR <- cgeneric("generic0", R = R,
  param = c(1, 0.05), scale = FALSE)
graph(mR)
prec(mR, theta = 0)
```

cgeneric_get	<i>cgeneric_get is an internal function used by graph, pred, initial, mu or prior methods for cgeneric.</i>
--------------	---

Description

The generic_get retrieve a model property specified by cmd on an cgeneric object. The functions listed below are for each cmd case.

Usage

```
cgeneric_get(
  model,
  cmd = c("graph", "Q", "initial", "mu", "log_prior"),
  theta,
  optimize = TRUE
)

## S3 method for class 'cgeneric'
initial(model)

## S3 method for class 'cgeneric'
mu(model, theta)

## S3 method for class 'cgeneric'
graph(model, optimize)

## S3 method for class 'cgeneric'
prec(model, theta, optimize)

## S3 method for class 'cgeneric'
prior(model, theta)
```

Arguments

model	a cgeneric object.
cmd	an string to specify which model element to get

theta	numeric vector with the model parameters. If missing, the <code>initial()</code> will be used.
optimize	logical indicating if it is to be returned only the elements and not as a sparse matrix.

Value

depends on cmd

numeric scalar (if numeric vector is provided for theta) or vector (if numeric matrix is provided for theta).

Functions

- `initial(cgeneric)`: Retrive the initial parameter(s) of an cgeneric model.
- `mu(cgeneric)`: Evaluate the mean for an cgeneric model.
- `graph(cgeneric)`: Retrieve the graph of an cgeneric object
- `prec(cgeneric)`: Retrieve the precision of an cgeneric object
- `prior(cgeneric)`: Evaluate the prior for an cgeneric model

See Also

check the examples in `cgeneric_generic0()`

Examples

```
old.par <- par(no.readonly = TRUE)

## Setting the prior parameters
prior.par <- c(1, 0.5) # P(sigma > 1) = 0.5
cmodel <- cgeneric(
  model = "iid", n = 10,
  param = prior.par)

## prior summaries: sigma and log-precision
(lamb <- -log(prior.par[2])/prior.par[1])
(smedian <- qexp(0.5, lamb))
(smean <- 1/lamb)

## mode: at the minimum of - log-prior
(lpmode <- optimize(function(x)
  -prior(cmodel, theta = x),
  c(-10, 30))$minimum)
## mean: integral of x*f(x)dx
(lpmean <- integrate(function(x)
  exp(prior(cmodel, theta = matrix(x, 1)))*x,
  -10, 30)$value)

## prior visualization: log(precision) and sigma
par(mfrow = c(1, 2))
plot(function(x)
```

```

exp(prior(cmodel, theta = matrix(x, nrow=1))),
  -3, 3, n = 601, xlab = "log-precision",
  ylab = "density")
abline(v = lpmode, lwd = 3, col = 2)
rug(-2*log(smedian), lwd = 3, col = 3)
rug(lpmean, lwd = 3, col = 4)
plot(function(x)
  exp(prior(cmodel,
    theta = matrix(
      -2*log(x),
      nrow = 1))+log(2)-log(x)),
    1/100, 10, n = 1000,
    xlab = expression(sigma),
    ylab = "density")
plot(function(x) dexp(x, lamb),
  1/100, 10, n = 1000,
  add = TRUE, lty = 2, col = 2)
rug(smedian, lwd = 3, col = 3)
rug(smean, lwd = 3, col = 4)

par(old.par)

```

extraconstr	<i>Kronecker (product) between extraconstr, implemented for kronecker() methods.</i>
-------------	--

Description

Kronecker (product) between extraconstr, implemented for [kronecker\(\)](#) methods.

Usage

```
kronecker_extraconstr(c1, c2, n1, n2)
```

Arguments

c1, c2	named list with two elements: A and e, where nrow(A) should be equal to length(e). This is an extraconstr.
n1, n2	integer with each model's length

Value

extraconstr

findGetFunction	<i>Search a function and retrieve it.</i>
-----------------	---

Description

Search a function and retrieve it.

Usage

```
findGetFunction(fName, package, debug = FALSE)
```

Arguments

fName	character with the name of the function
package	character with the package name
debug	logical indicating if it is to print intermediate progress finding

Details

if 'missing(package)' it will search on the loaded packages, first in the exported functions, and then among the non-exported ones. NOTE: 'package' can include any installed package, see [installed.packages\(\)](#)

Value

function. The (first) package name where it was found is returned as an attribute named "package"

inla.cgeneric.sample	<i>Draw samples from hyperparameters of a cgeneric model component from an inla output, like inla::inla.iidkd.sample().</i>
----------------------	---

Description

Draw samples from hyperparameters of a cgeneric model component from an inla output, like inla::inla.iidkd.sample().

Usage

```
inla.cgeneric.sample(
  n = 10000,
  result,
  name,
  model,
  from.theta,
  simplify = FALSE
)
```

Arguments

n	integer as the sample size.
result	an inla output.
name	character with the name of the model component in the set of random effects.
model	a cgeneric model
from.theta	a function to convert from theta to the desired output for each sample.
simplify	logical (see ?sapply).

Value

matrix (if n>1 and length(from.theta)>1) or numeric vector otherwise.

See Also

[prior.cgeneric\(\)](#)

is.zero	<i>Define the is.zero method</i>
---------	----------------------------------

Description

Define the is.zero method

Usage

```
is.zero(x, ...)

## Default S3 method:
is.zero(x, ...)

## S3 method for class 'matrix'
is.zero(x, ...)
```

Arguments

x	an R object
...	additional arguments

Value

logical

Methods (by class)

- `is.zero(default)`: The `is.zero.default` definition
- `is.zero(matrix)`: The `is.zero.matrix` definition

kronecker	<i>Kronecker (product) between cgeneric/rgeneric models, implemented as kronecker() methods.</i>
-----------	--

Description

Kronecker (product) between cgeneric/rgeneric models, implemented as [kronecker\(\)](#) methods.

Usage

```
## S4 method for signature 'cgeneric,cgeneric'
kronecker(X, Y, FUN = "*", make.dimnames = FALSE, ...)

## S4 method for signature 'cgeneric,rgeneric'
kronecker(X, Y, FUN = "*", make.dimnames = FALSE, ...)

## S4 method for signature 'rgeneric,cgeneric'
kronecker(X, Y, FUN = "*", make.dimnames = FALSE, ...)

## S4 method for signature 'rgeneric,rgeneric'
kronecker(X, Y, FUN = "*", make.dimnames = FALSE, ...)
```

Arguments

X	cgeneric or rgeneric
Y	cgeneric or rgeneric
FUN	see kronecker()
make.dimnames	see kronecker()
...	see kronecker()

Value

if 'X' and 'Y' are cgeneric return a cgeneric, else a rgeneric.

Examples

```
R <- Matrix(crossprod(diff(diag(4))))
m1 <- cgeneric("generic0", R = R, param = c(1, NA),
  scale = FALSE, useINLAprecomp = FALSE)
m2 <- cgeneric("iid", n = 3, param = c(1, 0.5),
  useINLAprecomp = FALSE)
k21 <- kronecker(m2, m1, useINLAprecomp = FALSE)
prec(k21, theta = 0.0)
```

 methods

Methods to work with a model.

Description

For a given model object query the initial, mu, log prior, graph or precision prec can be evaluated/retrieved.

Usage

```
initial(model)

mu(model, theta)

prior(model, theta)

graph(model, optimize)

prec(model, theta, optimize)

## Default S3 method:
prec(model, ...)

## S4 method for signature 'Matrix'
vcov(object, ...)

## S3 method for class 'inla'
prec(model, ...)
```

Arguments

model	object to represent a model
theta	numeric vector. For prior it can be a numeric matrix, with number of lines equal the size of theta and each column as a different case.
optimize	logical indicating if it is to be returned only the elements and not as a sparse matrix.
...	additional arguments passed on
object	Matrix supposed to be a sparse precision matrix

Value

the result of the desired query of the 'cgeneric' model. 'graph' and 'prec' can be either a vector (if optimize = TRUE) or a sparse matrix.

Functions

- `initial()`: Retrieve the initial model parameter(s)
- `mu()`: Evaluate the model's mean
- `prior()`: Evaluate the log-prior for a given theta
- `graph()`: Retrieve the models' graph
- `prec()`: Retrieve the precision for a given theta
- `prec(default)`: The default precision method computes the inverse of the variance
- `vcov(Matrix)`: The vcov method for sparse matrices
- `prec(inla)`: Define the prec method for an inla output object

See Also

[prior.cgeneric\(\)](#)

packageCheck

To check package version and load

Description

To check package version and load

Usage

```
packageCheck(name, minimum_version, quietly = FALSE)
```

Arguments

name	character with the name of the package
minimum_version	character with the minimum required version
quietly	logical indicating if messages shall be printed

Note

Original in inlabru package function `check_package_version_and_load`

rgeneric	<i>Define rgeneric methods.</i>
----------	---------------------------------

Description

Define rgeneric methods.

The rgeneric default method.

Usage

```
rgeneric(model, debug = FALSE, compile = TRUE, optimize = TRUE, ...)
```

```
## Default S3 method:
```

```
rgeneric(model, debug = FALSE, compile = TRUE, optimize = TRUE, ...)
```

Arguments

model	the model defined as a function. See the 'rgeneric' vignette from the INLA package.
debug	logical indicating debug state.
compile	logical indicating to compile the model.
optimize	logical indicating if only the elements of the precision matrix are returned.
...	additional arguments to be used internally for the model, for example, additional data.

Value

a `inla.rgeneric` object.

rgeneric-class	<i>The rgeneric class for <code>rgeneric()</code>.</i>
----------------	--

Description

The rgeneric class for `rgeneric()`.

Usage

```
## S3 method for class 'inla.rgeneric'
graph(model, ...)

## S3 method for class 'inla.rgeneric'
prec(model, ...)

## S3 method for class 'inla.rgeneric'
initial(model)

## S3 method for class 'inla.rgeneric'
mu(model, theta)

## S3 method for class 'inla.rgeneric'
prior(model, theta)
```

Arguments

model	a <code>inla.rgeneric</code> model object
...	additional parameter such as 'theta' If 'theta' is not supplied, initial will be taken.
theta	the parameter.

Functions

- `graph(inla.rgeneric)`: The graph method for 'inla.rgeneric'
- `prec(inla.rgeneric)`: The precision method for an `inla.rgeneric` object.
- `initial(inla.rgeneric)`: The initial method for 'inla.rgeneric'
- `mu(inla.rgeneric)`: The mu method for 'inla.rgeneric'
- `prior(inla.rgeneric)`: The prior metho for 'inla.rgeneric'

Sparse	<i>To store in i,j,x sparse matrix format</i>
--------	---

Description

To store in i,j,x sparse matrix format

Usage

```
Sparse(A, unique = TRUE, na.rm = FALSE, zeros.rm = FALSE)
```

Arguments

A	matrix or Matrix
unique	logical (default is TRUE) to ensure that the internal representation is unique and there are no duplicated entries. (Do not change this unless you know what you are doing.)
na.rm	logical (default is FALSE) indicating if it is to replace 'NA's in the matrix with zeros.
zeros.rm	logical (default is FALSE) indicating if it is to remove zeros in the matrix. Applied after na.rm.

Note

This is based in `INLA::inla.as.sparse()`, but allow all combinations of 'na.rm' and 'zeros.rm'.

upperPadding	<i>Padding (a list of) sparse matrices.</i>
--------------	---

Description

Padding (a list of) sparse matrices.

Usage

```
upperPadding(M, relative = FALSE, ...)
```

Arguments

M	'Matrix' (or a list of them).
relative	logical. If 'M' is a list, it indicates if it is to be returned a relative index and the value for each matrix. See details.
...	additional arguments passed to Sparse .

Details

This is useful to prepare a matrix, or a list of, sparse matrices for use in some 'cgeneric' code.

Define a graph of the union of the supplied matrices and return the row ordered diagonal plus upper triangle after padding with zeroes each one so that all the returned matrices have the same pattern.

If `relative=FALSE`, each columns of 'xx' is the elements of the corresponding matrix after being padded to fill the pattern of the union graph. If `relative=TRUE`, each element of 'xx' would be a list with a relative index, 'r', for each non-zero elements of each matrix is returned relative to the union graph, the non-lower elements, 'x', of the corresponding matrix, and a vector, 'o', with the number of non-zero elements for each line of each resulting matrix.

Value

If a unique matrix is given, return the upper triangle considering the 'T' representation in the `dgTMatrix`, from the `Matrix` package. If a list of matrices is given, return a list of two elements: 'graph' and 'xx'. The 'graph' is the union of the graph from each matrix. If `relative=FALSE`, 'xx' is a matrix with number of column equals the the number of matrices imputed. If `relative=TRUE`, it is a list of length equal the number of matrices imputed. See details.

Examples

```
A <- sparseMatrix(
  i = c(1, 1, 2, 3, 3, 5),
  j = c(2, 5, 3, 4, 5, 5),
  x = -c(0:3,NA,1), symmetric = TRUE)
A
upperPadding(A)
upperPadding(A, na.rm = TRUE)
upperPadding(A, zeros.rm = TRUE)
upperPadding(A, na.rm = TRUE, zeros.rm = TRUE)
B <- Diagonal(nrow(A), -colSums(A, na.rm = TRUE))
B
upperPadding(list(a = A, b = B), na.rm = TRUE, zeros.rm = TRUE)
upperPadding(list(a = A, b = B), relative = TRUE)
```

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