Package ‘gammSlice’

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Title Generalized Additive Mixed Model Analysis via Slice Sampling
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Depends KernSmooth, lattice, mgcv
Description Uses a slice sampling-based Markov chain Monte Carlo to conduct Bayesian fitting and inference for generalized additive mixed models. Generalized linear mixed models and generalized additive models are also handled as special cases of generalized additive mixed models. The methodology and software is described in Pham, T.H. and Wand, M.P. (2018). Australian and New Zealand Journal of Statistics, 60, 279-330 <DOI:10.1111/ANZS.12241>.
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gSlc

Generalized additive mixed model analysis via slice sampling

Description

Use slice sampling-based Markov chain Monte Carlo to fit a generalized additive mixed model.

Usage

```r
gSlc(formula, data = NULL, random = NULL, family, control = gSlc.control())
```

Arguments

- `formula`: Formula describing the generalized additive mixed model.
- `data`: Data frame containing the input data. This argument is optional.
- `random`: List describing random effects structure. This argument is optional.
- `family`: Distribution family of the response variable. The options are "binomial" and "poisson".
- `control`: Control options specified by `gSlc.control`.

Details

A Bayesian generalized additive mixed model is fitted to the input data according to specified formula. Such models are special cases of the general design generalized linear mixed models of Zhao, Staudenmayer, Coull and Wand (2003). Markov chain Monte Carlo, with slice sampling for the fixed and random effects, is used to obtain samples from the posterior distributions of the model parameters. Full details of the sampling scheme are in the appendix of Pham and Wand (2018).

Value

An object of class "gSlc". The functions `summary()` and `plot()` are used to obtain a summary and plot of the fits. The object is a list with the following components:

- `nu`: Matrix containing Markov chain Monte Carlo samples of the entire nu=(beta,u) vector. The rows correspond to Markov chain Monte Carlo replicates and the columns correspond to entries of the nu=(beta,u) vector.
- `beta`: Matrix containing Markov chain Monte Carlo samples of the beta vector corresponding to the linear components of the model. The rows correspond to Markov chain Monte Carlo replicates and the columns correspond to entries of the beta vector.
- `sigmaSquared`: Matrix containing Markov chain Monte Carlo samples of the entire sigma squared vector. The rows correspond to Markov chain Monte Carlo replicates and the columns correspond to entries of the sigmaSquared vector.
- `y`: Response data vector.
- `XlinPreds`: Matrix containing predictors that are purely linear components of the model.
linPredNames       Names of XlinPreds.
XsplPreds          Matrix containing predictors that are penalised spline components of the model.
splPredNames       Names of XsplPreds.
Zspl               Horizontal concatenation of each of the spline basis "Z" matrices used for smooth function components.
ncZspl             Vector giving the numbers of columns in the horizontal partition of Zspl corresponding to each smooth function component.
range.x.list       List containing values of the range.x input to the internal ZOsull() function.
intKnots.list      List containing values of the intKnots input to the internal ZOsull() function.
family             Character string indicating the family of the fitted model; either "binomial" or "poisson".
modelType          Character string indicating the type of model fitted.

Author(s)

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References

Slice sampling (with discussion). 

Generalized additive mixed model analysis via gamSlice. 
Australian and New Zealand Journal of Statistics, 60, 279-300.

General design Bayesian generalized linear mixed models. 
Statistical Science, 21, 35-51.

See Also

gSlc.control, plot.gSlc, summary.gSlc

Examples

## Not run:
# Example 1 of Pham & Wand (2018):

set.seed(39402)
m <- 100 ; n <- 2
betaTrue <- 0.5 ; betaxTrue <- 1.7
sigsqTrue <- 0.8 ; idnum <- rep(1:m,each=n)
x <- runif(m*n)
U <- rep(rnorm(m,0,sqrt(sigsqTrue)),each=n)
u <- 1/(1+exp(-(betaTrue+betaxTrue*x+U)))
y <- rbinom((m*n),1,u)
```r
fit1 <- gSlc(y ~ x, random = list(idnum = -1), family = "binomial")
summary(fit1)

# End(Not run)

# Not run:
# Example 2 of Pham & Wand (2018):

set.seed(53902)
n <- 400; x <- runif(n)
fTrue <- function(x) return(cos(4*pi*x) + 2*x - 1)
mu <- exp(fTrue(x)); y <- rpois(n,mu)
fit2 <- gSlc(y~s(x),family="poisson")
summary(fit2)
plot(fit2)

# End(Not run)

# Not run:
# Example 3 of Pham & Wand (2018):

set.seed(981127)
n <- 500; betax1True <- 0.5; x1 <- sample(c(0,1),n,replace=TRUE)
x2 <- runif(n); fTrue <- function(x) return(sin(2*pi*x))
mu <- 1/(1+exp(-(betax1True*x1+fTrue(x2)))) ; y <- rpois(n,mu)
y <- rbinom(n,1,mu)
fit3 <- gSlc(y ~ x1 + s(x2),family="binomial")
summary(fit3)
plot(fit3)

# End(Not run)

# Not run:
# Example 4 of Pham & Wand (2018):

set.seed(2966703)
m <- 100; n <- 10; x1 <- runif(m*n); x2 <- runif(m*n)
idnum <- rep(1:m,each=n); sigsqTrue <- 1
U <- rep(rnorm(m,0,sqrt(sigsqTrue)),each=n)
u <- exp(U + cos(4*pi*x1) + 2*x1 + sin(2*pi*x2^2)); y <- rpois(m*n,mu)
fit4 <- gSlc(y ~ s(x1) + s(x2),random = list(idnum=-1),family = "poisson")
summary(fit4)
plot(fit4)

# End(Not run)
```

*Controlling generalized additive mixed model fitting via slice sampling*
Description

Function for optional use in calls to gSlc() to control Markov chain Monte Carlo sample sizes values and other specifications for slice sampling-based fitting of generalized additive mixed models.

Usage

gSlc.control(nBurn=5000, nKept=5000, nThin=5, fixedEffPriorVar=1e10, sdpriorscale=1e5, numBasis=NULL, preTransfData=TRUE, msgCode=1)

Arguments

nBurn

The length of the Markov chain Monte Carlo burnin. The first nburnin Markov chain Monte Carlo samples are discarded. The default value of nburnin is 5000.

nKept

The number of kept Markov chain Monte Carlo samples after the burnin period. The default value of nkept is 5000.

nThin

Thinning factor applied to the retained Markov chain Monte Carlo samples. Setting nThin to be an integer greater than 1 results in every nthin value in the post-burnin samples being retained. The final Markov chain Monte Carlo sample size is an integer close to nIter divided by nIter. The default value of nThin is 5.

fixedEffPriorVar

The variance in the independent zero mean Normal priors of the fixed effect parameters after the data of each predictor have been transformed to the interval [0,1]. The default value of fixedEffPriorVar is 1e10.

sdPriorScale

The scale parameter in the Half Cauchy priors on standard deviation parameters after the data of each predictor have been transformed to the interval [0,1]. The default value of sdPriorScale is 1e5.

numBasis

Vector of positive integers specifying the number of spline basis functions to be used for each smooth function component.

preTransfData

Boolean flag:
TRUE = pre-transform each of the predictors to unit interval for Bayesian analysis with the priors specified by fixedEffPriorVar and sdPriorScale (the default),
FALSE = do not perform any pre-transformation of the predictors.

msgCode

A code for specification of the nature of messages printed concerning progress of the Markov chain Monte Carlo sampling:
0 = no messages printed,
1 = percentages 1,2,...,10 and then 20,30,...,100 (the default),
2 = percentages 1,2,...,100,
3 = percentages 10,20,...,100.

Author(s)

Tung Pham <tungstats@gmail.com> and Matt Wand <matt.wand@uts.edu.au>.
References


See Also
gSlc

Examples

```r
# Not run:
library(gammslice)
set.seed(39402); m <- 100; n <- 2
beta0true <- 0.5; betaXtrue <- 1.7; sigsQtrue <- 0.8
idnum <- rep(1:m,each=n); x <- runif(m*n)
U <- rep(rnorm(m,0,sqrt(sigsQtrue)),each=n)
mu <- 1/(1+exp(-(beta0true+betaXtrue*x+U)))
y <- rbinom(m*n,1,mu)
fit <- gSlc(y ~ x,random = list(idnum = ~1),family = "binomial")
summary(fit)

# Illustration of user-specified priors:
fitMyPriors <- gSlc(y ~ x,random = list(idnum = ~1),
                   family = "binomial",
                   control = gSlc.control(fixedEffPriorVar=1e13,
                                          sdPriorScale=1e3))
summary(fitMyPriors)

# Illustration of specification of larger Markov chain Monte Carlo samples:
fitBigMCMC <- gSlc(y ~ x,random = list(idnum = ~1),family = "binomial",
                   control = gSlc.control(nBurn=10000,nKept=8000,nThin=10))
summary(fitBigMCMC)

## End(Not run)
```

**indonRespir**

**Eespiratory infection in Indonesian children**

**Description**

Indonesian Children’s Health Study of respiratory infections for a cohort of 275 Indonesian children. The data are longitudinal with each child having between 1 and 6 repeated measurements.
Usage

```r
data(indonRespir)
```

Format

A data frame with 1200 observations on the following 12 variables:

- `idnum` child identification number.
- `respirInfec` indicator of presence of respiratory infection.
- `age` age of the child in years.
- `vitAdefic` indicator of Vitamin A deficiency:
  - 1 = the child had Vitamin A deficiency,
  - 0 = the child did not have Vitamin A deficiency.
- `female` indicator of child being female:
  - 1 = the child is female,
  - 0 = the child is male.
- `height` height of the child in centimeters.
- `stunted` indicator of the child being "short for his/her age":
  - 1 = the child is "short for his/her age",
  - 0 = the child is not "short for his/her age"
- `visit2` indicator that the child had exactly 2 clinical visits:
  - 1 = the exact number of clinical visits was 2,
  - 0 = the exact number of clinical visits was not 2.
- `visit3` indicator that the child had exactly 3 clinical visits:
  - 1 = the exact number of clinical visits was 3,
  - 0 = the exact number of clinical visits was not 3.
- `visit4` indicator that the child had exactly 4 clinical visits:
  - 1 = the exact number of clinical visits was 4,
  - 0 = the exact number of clinical visits was not 4.
- `visit5` indicator that the child had exactly 5 clinical visits:
  - 1 = the exact number of clinical visits was 5,
  - 0 = the exact number of clinical visits was not 5.
- `visit6` indicator that the child had exactly 6 clinical visits:
  - 1 = the exact number of clinical visits was 6,
  - 0 = the exact number of clinical visits was not 6.

Source


References

Examples

library(gammSlice); data(indonRespir)
plot(indonRespir$age,jitter(indonRespir$respInfec))

plot.gS1c  
Plot smooth function components of gS1c() fits

Description

Smooth function components of generalized additive mixed model fits obtained via gS1c are plotted.

Usage

## S3 method for class 'gS1c'
plot(x, gridSize=401, colour = TRUE, responseScale = FALSE,
     rug = TRUE, rugColour="dodgerblue", curveColour = "darkgreen",
     varBandPolygon = TRUE, varBandColour = "palegreen",
     xlab = NULL, ylab = NULL, bty = "l", cex.axis = 1,
     cex.lab = 1,...)

Arguments

x  
gS1c() fit object.

gridSize  
Number of grid points used in graphical display of smooth function fits.

colour  
Boolean flag:
TRUE = produce colour plots
FALSE = produce black and white plots.

responseScale  
Boolean flag:
TRUE = the smooth function fits are plotted on the response scale
FALSE = the smooth function fits are plotted on the link scale (the default).

rug  
Boolean flag:
TRUE = add rug graphics to the base of each smooth function plot showing the predictor data (the default).
FALSE = do not add rug graphs.

rugColour  
colour of the rug graphics. The default value is "dodgerblue".

curveColour  
colour of the curves in the smooth function display. The default value is "darkgreen".

varBandPolygon  
Boolean flag:
TRUE = display the variability band as a polygon (the default),
FALSE = display the variability band using dashed curves.

varBandColour  
colour of the variability band polygon in the smooth function display. The default value is "palegreen".

xlab  
optional argument: character string vector for horizontal labels for smooth function plots.
plot.gS1c

ylab optional argument: character string vector for vertical labels for smooth function plots.

bty character string which specifies the type of box which is drawn about plots. See help(par) for details. The default value is "l".

cex.axis positive number specifying the factor by which numbers along the axes are expanded.

cex.lab positive number specifying the factor by which characters in the axis labels are expanded.

... place-holder for other graphic parameters.

Details

For each smooth function component of the generalized additive mixed model specified in the call to gS1c the pointwise posterior mean is plotted along with a shaded polygon corresponding to pointwise 95% credible sets.

Author(s)

Tung Pham <tungstats@gmail.com> and Matt Wand <matt.wand@uts.edu.au>.

References


See Also

gS1c, summary.gS1c

Examples

library(gammSlice)
set.seed(53902)
n <- 400; x <- runif(n)
fTrue <- function(x) return(cos(4*pi*x) + 2*x - 1)
mu <- exp(fTrue(x)); y <- rpois(n,mu)
fit <- gS1c(y~s(x),family="poisson",control=gS1c.control(nBurn=200,nKept=200,nThin=1,msgCode=0))
plot(fit)
plot(fit,responseScale=TRUE,rug=FALSE)
points(x,y,col="dodgerblue")
Summary of the generalized additive mixed model fit produced by gSlc

Description

A graphical table showing, for key model parameters, the Markov chain Monte Carlo samples, diagnostic plots and numerical summaries.

Usage

```r
## S3 method for class 'gSlc'
summary(object, colour = TRUE, paletteNumber = 1, ...)
```

Arguments

- `object`: A `gSlc()` fit object.
- `colour`: Boolean flag:
  - `TRUE` = produce a colour graphical table,
  - `FALSE` = produce a black and white graphical table.
- `paletteNumber`: If `colour = TRUE` then there are two possible colour palettes. These are determined by whether `paletteNumber` is set to 1 or 2. The default is `paletteNumber = 1`.
- `...`: place-holder for additional arguments.

Details

The columns of the graphical table are:

1. parameter name,
2. trace plot of the Markov chain Monte Carlo sample,
3. plot of Markov chain Monte Carlo sample against its lag 1 sample,
4. sample autocorrelation function,
5. kernel density estimate of the posterior density function,
6. posterior mean and 95% credible interval.

Author(s)

Tung Pham <tungstats@gmail.com> and Matt Wand <matt.wand@uts.edu.au>.

References


See Also

gSlc, plot.gSlc
Examples

```r
library(gammSlice)
set.seed(39402); m <- 100; n <- 2
beta0True <- 0.5; betaTrue <- 1.7; sigsqTrue <- 0.8
idnum <- rep(1:m,each=n); x <- runif(m*n)
U <- rep(rnorm(m,0,sqrt(sigsqTrue)),each=n)
u <- 1/(1+exp(-(beta0True+betaTrue*x*U)))
y <- rbinom(m*n,1,u)
fit1 <- gSlc(y ~ x,random = list(idnum = ~1),family = "binomial",
control = gSlc.control(nBurn=150,nKept=100,nThin=1))
summary(fit1)
summary(fit1,paletteNumber = 2)
summary(fit1,colour = FALSE)

## Not run:
# Re-fit with higher Markov chain Monte Carlo sample:

fit2 <- gSlc(y ~ x,random = list(idnum = ~1),family = "binomial")
summary(fit2)
summary(fit2,paletteNumber = 2)
summary(fit2,colour = FALSE)

## End(Not run)
```

description

Data from a clinical trial in which two anti-fungal treatments for toenail infection are compared.

Usage

data(toenail)

Format

A data frame with 1908 observations on the following 5 variables:

- `idnum` patient identification number.
- `onycholysis` indicator concerning the severity of onycholysis:
  - 1 = moderate or severe onycholysis,
  - 0 = no or mild onycholysis.
- `terb` indicator of whether the treatment was terbinafine:
  - 1 = treatment was terbinafine,
  - 0 = treatment was itraconazole.
- `months` time in months since the the start of the trial when clinical visit took place.
- `visit` visit number.
References

parative trial of terbinafine 250 mg/day versus itraconazole 200 mg/day. *Journal of the American
Academy of Dermatology*, 38, S57-S63.

Examples

```r
library(gammSlice); data(toenail)
plot(jitter(toenail$terb), jitter(toenail$onycholysis))
```
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