Package ‘metropolis’

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Title  The Metropolis Algorithm
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Author  Alexander Keil [aut, cre]
Maintainer  Alexander Keil <akeil@unc.edu>
Description  Learning and using the Metropolis algorithm for Bayesian fitting of a generalized linear model. The package vignette includes examples of hand-coding a logistic model using several variants of the Metropolis algorithm. The package also contains R functions for simulating posterior distributions of Bayesian generalized linear model parameters using guided, adaptive, guided-adaptive and random walk Metropolis algorithms. The random walk Metropolis algorithm was originally described in Metropolis et al (1953); <doi:10.1063/1.1699114>.
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as.mcmc.metropolis.samples

Convert glm_metropolis output to mcmc object from package coda

Description

Allows use of useful functions from coda package

Usage

## S3 method for class 'metropolis.samples'
as.mcmc(x, ...)

Arguments

x                    an object from the function "metropolis"
...                   not used

Details

TBA

Value

An object of type "mcmc" from the coda package
Examples

```r
## Not run:
library("coda")
dat = data.frame(y = rbinom(100, 1, .5), x1=runif(100), x2 = runif(100))
res = metropolis_glm(y ~ x1 + x2, data=dat, family=binomial(), iter=10000, burnin=3000,
adapt=TRUE, guided=TRUE, block=FALSE)
res2 = as.mcmc(res)
summary(res2)

## End(Not run)
```

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**expit**  
*Inverse logit transform*

Description

Inverse logit transform

Usage

```r
expit(mu)
```

Arguments

- `mu` log-odds

Value

returns a scalar or vector the same length as `mu` with values that are the inverse logit transform of `mu`

Examples

```r
logodds = rnorm(10)
expit(logodds)
logodds = log(1.0)
expit(logodds)
```
logistic_ll  

**Description**

logistic log likelihood

**Usage**

logistic_ll(y, X, par)

**Arguments**

- **y**: binary outcome
- **X**: design matrix
- **par**: vector of model coefficients

**Value**

a scalar quantity proportional to a binomial likelihood with logistic parameterization, given y, X, and par

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**magfields**

doi: [https://doi.org/10.1093/oxfordjournals.aje.a114943](https://doi.org/10.1093/oxfordjournals.aje.a114943)

**Description**


**Usage**

magfields

**Format**

A data frame with 234 rows and 2 variables:

- **y**: childhood leukemia
- **x**: exposure to magnetic field
Description

metropolis.control

Usage

metropolis.control(
  adapt.start = 25,
  adapt.window = 200,
  adapt.update = 25,
  min.sigma = 0.001,
  prop.sigma.start = 1,
  scale = 2.4
)

Arguments

adapt.start start adapting after this many iterations; set to iter+1 to turn off adaptation
adapt.window base acceptance rate on maximum of this many iterations
adapt.update frequency of adaptation
min.sigma minimum of the proposal distribution standard deviation (if set to zero, posterior may get stuck)
prop.sigma.start starting value, or fixed value for proposal distribution s standard deviation
scale scale value for adaptation (how much should the posterior variance estimate be scaled by?). Scale/sqrt(p) is used in metropolis_glm function, and Gelman et al. (2014, ISBN: 9781584883883) recommend a scale of 2.4

@return A list of parameters used in fitting with the following named objects adapt.start, adapt.window,adapt.update,min.sigma,prop.sigma.start,scale

Description

Use the Metropolis Hastings algorithm to estimate Bayesian glm parameters

This function carries out the Metropolis algorithm.
Usage

metropolis_glm(
  f,
  data,
  family = binomial(),
  iter = 100,
  burnin = round(iter/2),
  pm = NULL,
  pv = NULL,
  chain = 1,
  prop.sigma.start = 0.1,
  inits = NULL,
  adaptive = TRUE,
  guided = FALSE,
  block = TRUE,
  saveproposal = FALSE,
  control = metropolis.control()
)

Arguments

f an R style formula (e.g. y ~ x1 + x2)
data an R data frame containing the variables in f
family R glm style family that determines model form: gaussian() or binomial()
iternumber of iterations after burnin to keep
burnin number of iterations at the beginning to throw out (also used for adaptive phase)
pm vector of prior means for normal prior on log(scale) (if applicable) and regression coefficients (set to NULL to use uniform priors)
pv vector of prior variances for normal prior on log(scale) (if applicable) and regression coefficients (set to NULL to use uniform priors)
chainchain id (plan to deprecate)
prop.sigma.start proposal distribution standard deviation (starting point if adapt=TRUE)
inits NULL, a vector with length equal to number of parameters (intercept + x + scale; gaussian() family only model only), or "glm" to set priors based on an MLE fit
adaptive logical, should proposal distribution be adaptive? (TRUE usually gives better answers)
guided logical, should the "guided" algorithm be used (TRUE usually gives better answers)
block logical or a vector that sums to total number of parameters (e.g. if there are 4 random variables in the model, including intercept, then block=c(1,3) will update the intercept separately from the other three parameters.) If TRUE, then updates each parameter 1 by 1. Using guide=TRUE with block as a vector is not advised
saveproposal (logical, default=FALSE) save the rejected proposals (block=TRUE only)?
control parameters that control fitting algorithm. See metropolis.control()
Details

Implements the Metropolis algorithm, which allows user specified proposal distributions or implements an adaptive algorithm as described by Gelman et al. (2014, ISBN: 9781584883883). This function also allows the "Guided" Metropolis algorithm of Gustafson (1998) doi: 10.1023/A:1008880707168. Note that by default all parameters are estimated simultaneously via "block" sampling, but this default behavior can be changed with the "block" parameter. When using guided=TRUE, block should be set to FALSE.

Value

An object of type "metropolis.samples" which is a named list containing posterior MCMC samples as well as some fitting information.

Examples

dat = data.frame(y = rbinom(100, 1, 0.5), x1=runif(100), x2 = runif(100))

res = metropolis_glm(y ~ x1 + x2, data=dat, family=binomial(), iter=1000, burnin=3000, adapt=TRUE, guided=TRUE, block=FALSE)

res

apply(res$parms, 2, mean)

glm(y ~ x1 + x2, family=binomial(), data=dat)

dat = data.frame(y = rnorm(100, 1, 0.5), x1=runif(100), x2 = runif(100), x3 = rpois(100, .2))

res = metropolis_glm(y ~ x1 + x2 + factor(x3), data=dat, family=gaussian(), inits="glm", iter=10000, burnin=3000, adapt=TRUE, guide=TRUE, block=FALSE)

apply(res$parms, 2, mean)

glm(y ~ x1 + x2+ factor(x3), family=gaussian(), data=dat)

Description

Gaussian log likelihood

Usage

normal_ll(y, X, par)

Arguments

y binary outcome
X design matrix
par vector of gaussian scale parameter followed by model coefficients
Value

a scalar quantity proportional to a normal likelihood with linear parameterization, given y, X, and par

plot.metropolis.samples

Plot the output from the metropolis function

Description

This function allows you to summarize output from the metropolis function.

Usage

## S3 method for class 'metropolis.samples'
plot(x, keepburn = FALSE, parms = NULL, ...)

Arguments

x the outputted object from the "metropolis_glm" function
keepburn keep the burnin iterations in calculations (if adapt=TRUE, keepburn=TRUE
parms names of parameters to plot (plots the first by default, if TRUE, plots all)
... other arguments to plot

Details

TBA

Value

None

Examples

dat = data.frame(y = rbinom(100, 1, 0.5), x1=runif(100), x2 = runif(100))
res = metropolis_glm(y ~ x1 + x2, data=dat, family=binomial(), iter=10000, burnin=3000, adapt=TRUE, guided=TRUE, block=FALSE)
plot(res)
### print.metropolis.samples

*Print a metropolis.samples object*

**Description**

This function allows you to summarize output from the "metropolis_glm" function.

**Usage**

```r
## S3 method for class 'metropolis.samples'
print(x, ...)
```

**Arguments**

- `x`: a "metropolis.samples" object from the function "metropolis_glm"
- `...`: not used.

**Details**

None

**Value**

An unmodified "metropolis.samples" object (invisibly)

### summary.metropolis.samples

*Summarize a probability distribution from a Markov Chain*

**Description**

This function allows you to summarize output from the metropolis function.

**Usage**

```r
## S3 method for class 'metropolis.samples'
summary(object, keepburn = FALSE, ...)
```

**Arguments**

- `object`: an object from the function "metropolis"
- `keepburn`: keep the burnin iterations in calculations (if adapt=TRUE, keepburn=TRUE will yield potentially invalid summaries)
- `...`: not used
Details

TBA

Value

returns a list with the following fields: nsamples: number of simulated samples sd: standard deviation of parameter distributions se: standard deviation of parameter distribution means ESS_parms: effective sample size of parameter distribution means postmean: posterior means and normal based 95% credible intervals postmedian: posterior medians and percentile based 95% credible intervals postmode: posterior modes and highest posterior density based 95% credible intervals

Examples

dat = data.frame(y = rbinom(100, 1, 0.5), x1=runif(100), x2 = runif(100))
res = metropolis_glm(y ~ x1 + x2, data=dat, family=binomial(), iter=10000, burnin=3000, adapt=TRUE, guided=TRUE, block=FALSE)
summary(res)
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