Package ‘pgdraw’

October 14, 2022

Type Package

Title Generate Random Samples from the Polya-Gamma Distribution

Version 1.1

Date 2019-02-19

Author Daniel F. Schmidt [aut, cph, cre],
Enes Makalic [aut, cph]

Maintainer Daniel F. Schmidt <daniel.schmidt@monash.edu>

Description Generates random samples from the Polya-Gamma distribution using an implementation of the algorithm described in J. Windle's PhD thesis (2013) <https://repositories.lib.utexas.edu/bitstream/handle/2152/21842/WINDLE-DISSERTATION-2013.pdf>. The underlying implementation is in C.

License GPL (>= 3)

Imports Rcpp (>= 0.12.16)

NeedsCompilation yes

LinkingTo Rcpp

RoxygenNote 6.1.0

Repository CRAN

Date/Publication 2019-02-19 13:00:03 UTC

R topics documented:

pgdraw-package *The pgdraw package*

Description

This package contains a function to generates random samples from the Polya-Gamma distribution using an implementation of the algorithm described in J. Windle's PhD thesis. A frequent application of this distribution is in Bayesian analysis of logistic regression models.

Details

The underlying implementation is in C.

For usage, see the examples in `pgdraw` and `pgdraw.moments`.

Note

To cite this package please reference:

Makalic, E. & Schmidt, D. F. High-Dimensional Bayesian Regularised Regression with the BayesReg Package arXiv:1611.06649 [stat.CO], 2016 https://arxiv.org/pdf/1611.06649.pdf

A MATLAB-compatible implementation of the sampler in this package can be obtained from:

http://dschmidt.org/?page_id=189

Author(s)

Daniel Schmidt <daniel.schmidt@monash.edu>

Faculty of Information Technology, Monash University, Australia

Enes Makalic <emakalic@unimelb.edu.au>

Centre for Epidemiology and Biostatistics, The University of Melbourne, Australia

References

Jesse Bennett Windle Forecasting High-Dimensional, Time-Varying Variance-Covariance Matrices with High-Frequency Data and Sampling Polya-Gamma Random Variates for Posterior Distributions Derived from Logistic Likelihoods PhD Thesis, 2013

Bayesian Inference for Logistic Models Using Polya-Gamma Latent Variables Nicholas G. Polson, James G. Scott and Jesse Windle Journal of the American Statistical Association Vol. 108, No. 504, pp. 1339–1349, 2013

Chung, Y.: Simulation of truncated gamma variables Korean Journal of Computational & Applied Mathematics, 1998, 5, 601-610

See Also

`pgdraw`, `pgdraw.moments`

pgdraw *Generate random samples from the Polya-Gamma distribution, PG(b,c)*

Description

Generate random samples from the Polya-Gamma distribution

Usage

```
pgdraw(b, c)
```

Arguments

b	Either a single integer scalar, or a vector of integers, corresponding to the 'b' parameter for the PG(b,c) distribution. If b is a scalar, then the same value is paired with every value in c; if b is a vector then it must be of the same length as the c parameter.
c	A vector of real numbers corresponding to the 'c' parameter for the PG(b,c) distribution.

Value

A vector of samples from the Polya-Gamma distribution, one for each entry of c

Details

This code generates random variates from the Polya-Gamma distribution with desired 'b' and 'c' parameters. The underlying code is written in C and is an implementation of the algorithm described in J. Windle's PhD thesis.

The main application of the Polya-Gamma distribution is in Bayesian analysis as it allows for a data augmentation (via a scale mixture of normals) approach for representation of the logistic regression likelihood (see Example 2 below).

Note

To cite this package please reference:

Makalic, E. & Schmidt, D. F. High-Dimensional Bayesian Regularised Regression with the BayesReg Package arXiv:1611.06649 [stat.CO], 2016 https://arxiv.org/pdf/1611.06649.pdf

A MATLAB-compatible implementation of the sampler in this package can be obtained from:

http://dschmidt.org/?page_id=189

References

Jesse Bennett Windle Forecasting High-Dimensional, Time-Varying Variance-Covariance Matrices with High-Frequency Data and Sampling Polya-Gamma Random Variates for Posterior Distributions Derived from Logistic Likelihoods, PhD Thesis, 2013

Bayesian Inference for Logistic Models Using Polya-Gamma Latent Variables Nicholas G. Polson, James G. Scott and Jesse Windle, Journal of the American Statistical Association Vol. 108, No. 504, pp. 1339–1349, 2013

Chung, Y.: Simulation of truncated gamma variables, Korean Journal of Computational & Applied Mathematics, 1998, 5, 601-610

See Also

pgdraw.moments

Examples

```
# -----------------------------------------------------------------
# Example 1: Simulated vs exact moments
u = matrix(1,1e6,1)
x = pgdraw(1,0.5*u)
mean(x)
var(x)
pgdraw.moments(1,0.5)

x = pgdraw(2,2*u)
mean(x)
var(x)
pgdraw.moments(2,2)


# -----------------------------------------------------------------
# Example 2: Simple logistic regression
#   Sample from the following Bayesian hierarchy:
#    y_i ~ Be(1/(1+exp(-b)))
#    b   ~ uniform on R (improper)
#
#   which is equivalent to
#    y_i - 1/2 ~ N(b, 1/omega2_i)
#    omega2_i  ~ PG(1,0)
#    b         ~ uniform on R
#
sample_simple_logreg <- function(y, nsamples)
{
  n = length(y)
  omega2 = matrix(1,n,1)   # Polya-Gamma latent variables
  beta   = matrix(0,nsamples,1)

  for (i in 1:nsamples)
  {
    # Sample 'beta'
    s = sum(omega2)
```

```
    m = sum(y-1/2)/s
    beta[i] = rnorm(1, m, sqrt(1/s))
    # Sample P-G L.Vs
    omega2 = pgdraw(1, matrix(1,n,1)*beta[i])
  }
  return(beta)
}

# 3 heads, 7 tails; ML estimate of p = 3/10 = 0.3
y = c(1,1,1,0,0,0,0,0,0,0)

# Sample
b = sample_simple_logreg(y, 1e4)
hist(x=b)

# one way of estimating of 'p' from posterior samples
1/(1+exp(-mean(b)))
```

`pgdraw.moments` *Compute exact first and second moments for the Polya-Gamma distribution, PG(b, c)*

Description

Compute exact first and second moments for the Polya-Gamma distribution

Usage

```
pgdraw.moments(b, c)
```

Arguments

b	The 'b' parameter of the Polya-Gamma distribution.
c	The 'c' parameter of the Polya-Gamma distribution.

Value

A list containing the mean and variance.

Details

This code computes the exact mean and variance of the Polya-Gamma distribution for the specified parameters.

References

Jesse Bennett Windle Forecasting High-Dimensional, Time-Varying Variance-Covariance Matrices with High-Frequency Data and Sampling Polya-Gamma Random Variates for Posterior Distributions Derived from Logistic Likelihoods PhD Thesis, 2013

Bayesian Inference for Logistic Models Using Polya-Gamma Latent Variables Nicholas G. Polson, James G. Scott and Jesse Windle Journal of the American Statistical Association Vol. 108, No. 504, pp. 1339–1349, 2013

See Also

`pgdraw`

Examples

```
# -----------------------------------------------------------------
# Example: Simulated vs exact moments

u = matrix(1,1e6,1)
x = pgdraw(1,0.5*u)
mean(x)
var(x)
pgdraw.moments(1,0.5)

x = pgdraw(2,2*u)
mean(x)
var(x)
pgdraw.moments(2,2)
```

Index