

Package ‘BayesLogit’

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Title PolyaGamma Sampling

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Description Tools for sampling from the PolyaGamma distribution based on Polson, Scott, and Windle (2013) <doi:10.1080/01621459.2013.829001>. Useful for logistic regression.

License GPL (>= 3)

Depends R (>= 3.6.0)

Suggests testthat (>= 3.0.0)

BugReports <https://github.com/jwindle/BayesLogit/issues>

URL <https://github.com/jwindle/BayesLogit>

NeedsCompilation yes

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pg.m1

*Polya-Gamma Distribution Moments***Description**

Compute the first moment (mean), second moment, and variance of the Polya-Gamma distribution $PG(b, z)$.

Usage

```
pg.m1(b, z)
pg.m2(b, z)
pg.var(b, z)
```

Arguments

b Shape parameter. Must be positive.
z Tilt parameter. May be any real number.

Details

For $X \sim PG(b, z)$, the moments are derived from the moment generating function

$$E[e^{tX}] = \left(\frac{\cosh(z/2)}{\cosh(\sqrt{z^2/4 - t}/2)} \right)^b.$$

The first moment is

$$E[X] = \frac{b \tanh(z/2)}{2z}, \quad z \neq 0,$$

with $E[X] = b/4$ when $z = 0$. Taylor series are used near $z = 0$ for numerical stability.

`pg.m2` returns $E[X^2]$, and `pg.var` returns $\text{Var}(X) = E[X^2] - E[X]^2$.

Value

A scalar giving the requested moment.

References

Nicholas G. Polson, James G. Scott, and Jesse Windle. Bayesian inference for logistic models using Polya-Gamma latent variables. <https://arxiv.org/abs/1205.0310>

See Also

[rpg](#)

Examples

```
## Mean and variance of PG(1, 0)
pg.m1(1, 0) # 0.25
pg.var(1, 0) # 1/24

## Compare sample moments to theoretical values
set.seed(1)
x <- rpg(10000, h = 2, z = 1)
mean(x)
pg.m1(2, 1)

var(x)
pg.var(2, 1)
```

rpg

Polya-Gamma Random Variates

Description

Generate random variates from the Polya-Gamma distribution.

Usage

```
rpg(num=1, h=1, z=0.0)
rpg.gamma(num=1, h=1, z=0.0, trunc=200)
rpg.devroye(num=1, h=1, z=0.0)
rpg.sp(num=1, h=1, z=0.0)
rpg.gamma.R(num=1, h=1, z=0.0, trunc=200)
rpg.devroye.R(num=1, h=1, z=0.0)
rpg.sp.R(num=1, h=1, z=0.0)
```

Arguments

num	The number of random variates to simulate.
h	Shape parameter. h must be ≥ 1 if not using sum of gammas method.
z	Parameter associated with tilting.
trunc	The number of elements used in sum of gammas approximation.

Details

A random variable X with distribution $\text{PG}(h,z)$ is distributed like

$$X \sim \sum_{k=1}^{\infty} G(h, 1) / (2\pi^2(k - 1/2)^2 + z^2/2).$$

The density for X may be derived by exponentially tilting the $\text{PG}(h,0)$ density:

$$p(x|h, z) \propto \exp(-xz^2/2)p(x|h, 0).$$

Different methods for generating this random variable are implemented, each of which is useful for certain parameters. The parameters supplied by the user automatically determine which method is used. One may manually call each routine using `rpg.METHOD`. Functions ending in ".R" are pure R implementations.

You may call `rpg` when n and z are vectors.

Value

This function returns `num` Polya-Gamma samples.

References

Nicholas G. Polson, James G. Scott, and Jesse Windle. Bayesian inference for logistic models using Polya-Gamma latent variables. <https://arxiv.org/abs/1205.0310>

Examples

```
h = c(1, 2, 3);
z = c(4, 5, 6);

## Devroye-like method -- only use if h contains integers, preferably small integers.
X = rpg.devroye(100, h, z);

h = c(1.2, 2.3, 3.2);
z = c(4, 5, 6);

## Sum of gammas method -- this is slow.
X = rpg.gamma(100, h, z);

h = c(1, 4, 2.3);
z = c(4, 5, 6);

## Hybrid method -- automatically chooses best procedure.
X = rpg(100, h, z);
```

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