Package ‘pgnorm’

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Type Package
Title The p-Generalized Normal Distribution
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Description Evaluation of the pdf and the cdf of the univariate, noncentral, p-generalized normal distribution. Sampling from the univariate, noncentral, p-generalized normal distribution using either the p-generalized polar method, the p-generalized rejecting polar method, the Monty Python method, the Ziggurat method or the method of Nardon and Pianca. The package also includes routines for the simulation of the bivariate, p-generalized uniform distribution and the simulation of the corresponding angular distribution.
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Description

The pgnorm-package includes routines to evaluate (cdf,pdf) and simulate the univariate $p$-generalized normal distribution with form parameter $p$, expectation $\text{mean}$ and standard deviation $\sigma$. The pdf of this distribution is given by

\[ f(x, p, \text{mean}, \sigma) = \left(\frac{\sigma}{\sigma_p}\right)^p \exp\left(-\frac{p}{\sigma_p} \left|\frac{x - \text{mean}}{\sigma}\right|^p\right), \]

where $C_p = p^{1-1/p}/2/\Gamma(1/p)$ and $\sigma_p^2 = p^{2/p} \Gamma(3/p)/\Gamma(1/p)$, which becomes

\[ f(x, p, \text{mean}, \sigma) = C_p \exp\left(-\frac{|x|^p}{\sigma_p}\right), \]

if $\sigma = \sigma_p$ and $\text{mean} = 0$. The random number generation can be realized with one of five different simulation methods including the $p$-generalized polar method, the $p$-generalized rejecting polar method, the Monty Python method, the Ziggurat method and the method of Nardon and Pianca. Additionally to the simulation of the $p$-generalized normal distribution, the related $p$-generalized uniform distribution on the $p$-generalized unit circle and the corresponding angular distribution can be simulated by using the functions "rpgunif" and "rpgangular", respectively.

Details

Package: pgnorm
Type: Package
Version: 2.0
Date: 2015-11-23
License: GPL (>= 2)
LazyLoad: yes

Author(s)

Steve Kalke <steve.kalke@googlemail.com>
References


Examples

```r
y <- rpgnorm(10, 3)
```

---

**datasetpgnmp1**

*Dataset 1 of the Monty Python method*

**Description**

The dataset contains tail algorithm constants for sampling from the tail of the $p$-generalized normal distribution in context of a simulation of the $p$-generalized normal distribution with the Monty Python method.

**Usage**

```r
data(datasetpgnmp1)
```

**Examples**

```r
data(datasetpgnmp1)
```

---

**datasetpgnmp2**

*Dataset 2 of the Monty Python method*

**Description**

The dataset contains optimal rectangle widths in context of a simulation of the $p$-generalized normal distribution with the Monty Python method.

**Usage**

```r
data(datasetpgnmp2)
```

**Examples**

```r
data(datasetpgnmp2)
```
**datasetpgnzig**

*Dataset of the Ziggurat method*

**Description**

The dataset contains tail algorithm constants for sampling from the tail of the $p$-generalized normal distribution in context of a simulation of the $p$-generalized normal distribution with the Ziggurat method.

**Usage**

```r
data(datasetpgnzig)
```

**Examples**

```r
data(datasetpgnzig)
```

---

**dpgnorm**

*A function to evaluate the $p$-generalized normal density*

**Description**

The function evaluates the density $f(x, p, mean, sigma)$ of the univariate $p$-generalized normal distribution according to

$$f(x, p, mean, \sigma) = (\frac{\sigma_p}{\sigma}) C_p \exp \left( - \left( \frac{\sigma_p}{\sigma} \right)^p \frac{|x - mean|^p}{p} \right),$$

where $C_p = p^{1-1/p}/2/\Gamma(1/p)$ and $\sigma_p^2 = p^{2/p} \Gamma(3/p)/\Gamma(1/p)$.

**Usage**

```r
dpgnorm(y, p, mean, sigma)
```

**Arguments**

- **y**
  - The real argument of the function.
- **p**
  - A positive number expressing the form parameter of the distribution. The default is 2.
- **mean**
  - A real number expressing the expectation of the distribution. The default is 0.
- **sigma**
  - A positive number expressing the standard deviation of the distribution. The default is $\sigma_p$.

**Value**

A real number.
ppgnorm

Author(s)
Steve Kalke

References

Examples

```R
y<-dpgnorm(0.3,1,2)
```

---

Description

The function evaluates the cdf of the univariate p-generalized normal distribution according to the density

\[ f(x, p, \text{mean}, \sigma) = (\sigma_p / \sigma) C_p \exp \left( - \left( \frac{\sigma_p}{\sigma} \right)^p \frac{|x - \text{mean}|^p}{p} \right), \]

where \( C_p = p^{1 - 1/p} / 2 / \Gamma(1/p) \) and \( \sigma_p^2 = p^{2/p} \Gamma(3/p) / \Gamma(1/p) \).

Usage

```R
ppgnorm(y, p, mean, sigma)
```

Arguments

- `y` A real number, the argument of the function.
- `p` A positive number expressing the form parameter of the distribution. The default is 2.
- `mean` A real number expressing the expectation of the distribution. The default is 0.
- `sigma` A positive number expressing the standard deviation of the distribution. The default is \( \sigma_p \).

Value

A real number.

Author(s)
Steve Kalke
References


Examples

```r
y <- rpgangular(10000, 3)
```

---

**rpgangular**

A random number generator for the angular distribution

### Description

The function simulates the univariate angular distribution corresponding to the \( p \)-generalized uniform distribution on the \( p \)-generalized unit circle.

### Usage

```r
rpgangular(n, p)
```

### Arguments

- **n**: The natural number of random variables to be simulated.
- **p**: A positive number expressing the form parameter of the distribution. The default is 2.

### Value

An \( n \)-dimensional, real vector.

### Author(s)

Steve Kalke

### References


### Examples

```r
y <- rpgangular(10000, 3)
```
Description

The function simulates the univariate \( p \)-generalized normal distribution by using one of the following methods: the \( p \)-generalized polar method (pgenpolar), the \( p \)-generalized rejecting polar method (pgenpolarrej), the Monty Python method (montypython), the Ziggurat method (ziggurat) and the method of Nardon and Pianca (nardonpianca).

Usage

\[
\text{rpgnorm}(n, p, \text{mean}, \text{sigma}, \text{method})
\]

Arguments

- **n**: The natural number of random variables to be simulated.
- **p**: A positive number expressing the form parameter of the distribution. The default is 2. In case of the Monty Python method and the Ziggurat method, \( p \) can be chosen from \((1, \infty) \cup \{0.25, 0.45, 0.5, 0.6, 0.75\}\).
- **mean**: A real number expressing the expectation of the distribution. The default is 0.
- **sigma**: A positive number expressing the standard deviation of the distribution. The default is \( \sigma_p = p^{1/p} \sqrt{\Gamma(3/p)/\Gamma(1/p)} \), the natural standard deviation of the \( p \)-generalized normal distribution.
- **method**: A string expressing the method to be used for the simulation ("pgenpolar", "pgenpolarrej", "montypython", "ziggurat" or "nardonpianca"). The default is "nardonpianca".

Value

An \( n \)-dimensional, real vector.

Author(s)

Steve Kalke

References


Examples

\[
y \leftarrow \text{rpgnorm}(10000, 3, \text{method}="\text{pgenpolar}\"
\]
rpgnorm_montypython  A random number generator for the $p$-generalized normal distribution

Description

The function simulates the univariate, central, $p$-generalized normal distribution by using the Monty Python method.

Usage

rpgnorm_montypython(n,p)

Arguments

n  The natural number of random variables to be simulated.

p  A positive number expressing the form parameter of the distribution. The default is 2. In case of the Monty Python method, $p$ can be chosen from $(1, \infty) \cup \{0.25, 0.45, 0.5, 0.6, 0.75\}$.

Value

An $n$-dimensional, real vector.

Author(s)

Steve Kalke

References


Examples

y<-rpgnorm_montypython(10000,3)
rpgnorm_nardonpianca

Description

The function simulates the univariate, central, \( p \)-generalized normal distribution by using the method of Nardon and Pianca.

Usage

\[
\text{rpgnorm_nardonpianca}(n, p)
\]

Arguments

- \( n \) The natural number of random variables to be simulated.
- \( p \) A positive number expressing the form parameter of the distribution. The default is 2.

Value

An \( n \)-dimensional, real vector.

Author(s)

Steve Kalke

References


Examples

\[
y \leftarrow \text{rpgnorm_nardonpianca}(10000, 3)
\]

rpgnorm_pgenpolar

Description

The function simulates the univariate, central, \( p \)-generalized normal distribution by using the \( p \)-generalized polar method.

Usage

\[
\text{rpgnorm_pgenpolar}(n, p)
\]
Arguments

\( n \)  
The natural number of random variables to be simulated.

\( p \)  
A positive number expressing the form parameter of the distribution. The default is 2.

Value

An \( n \)-dimensional, real vector.

Author(s)

Steve Kalke

References


Examples

\[ y \leftarrow \text{rpgnorm\_pgenpolar}(10000,3) \]

---

rpgnorm\_pgenpolarrej   A random number generator for the \( p \)-generalized normal distribution

Description

The function simulates the univariate, central, \( p \)-generalized normal distribution by using the \( p \)-generalized rejecting polar method.

Usage

rpgnorm\_pgenpolarrej(n,p)

Arguments

\( n \)  
The natural number of random variables to be simulated.

\( p \)  
A positive number expressing the form parameter of the distribution. The default is 2.

Value

An \( n \)-dimensional, real vector.

Author(s)

Steve Kalke
rpgnorm_ziggurat

References


Examples

\[
y \leftarrow \text{rpgnorm_pgenpolarrej}(10000, 3)
\]

### Description

The function simulates the univariate, central, \( p \)-generalized normal distribution by using the Ziggurat method.

### Usage

\[
rpgnorm_ziggurat(n, p, x)
\]

### Arguments

- \( n \): The natural number of random variables to be simulated.
- \( p \): A positive number expressing the form parameter of the distribution. The default is 2. In case of the Ziggurat method, \( p \) can be chosen from \((1, \infty) \cup \{0.25, 0.45, 0.5, 0.6, 0.75\}\).
- \( x \): (optional) A real vector containing the \( 2^8 - 1 \) rightmost endpoints of the \( 2^8 \) ziggurat-rectangles.

### Value

An \( n \)-dimensional, real vector.

### Author(s)

Steve Kalke

### References


### Examples

\[
y \leftarrow \text{rpgnorm_ziggurat}(10000, 3)
\]
rpgunif

A random number generator for the \( p \)-generalized uniform distribution

Description
The function simulates the bivariate, \( p \)-generalized uniform distribution on the \( p \)-generalized unit circle.

Usage
rpgunif(n,p)

Arguments
\( n \) The natural number of random vectors to be simulated.
\( p \) A positive number expressing the form parameter of the distribution. The default is 2.

Value
A real \( n \times 2 \) matrix.

Author(s)
Steve Kalke

References

Examples
\( y \leftarrow \text{rpgunif}(10000, 3) \)

zigsetup

A function for setting up the Ziggurat.

Description
The function approximates the rightmost x-coordinates of the first \( n-1 \) rectangles defining the Ziggurat in case of the central, \( p \)-generalized normal distribution.

Usage
zigsetup(p, n, tol)
Arguments

- **p**
  A positive number expressing the form parameter of the distribution. The default is 2. In case of the Ziggurat method, p can be chosen from \( (1, \infty) \cup \{0.25, 0.45, 0.5, 0.6, 0.75\} \).

- **n**
  The number of rectangles that build up the Ziggurat. The default is \(2^8\).

- **tol**
  A positive number expressing the approximation accuracy of the function. The default is \(10^{-9}\).

Value

An \((n - 1)\)-dimensional, real vector.

Author(s)

Steve Kalke

References


Examples

```r
y<-zigsetup(3,20,10^(-6))
```
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