Package ‘distr6’

July 14, 2021

**Title**  The Complete R6 Probability Distributions Interface

**Version**  1.5.4


**Imports**  checkmate, data.table, R6, R62S3 (&gt;= 1.4.0), set6 (&gt;= 0.2.0), stats, Rcpp

**Suggests**  cubature, GoFKernel, knitr, testthat, rmarkdown, magrittr, extraDistr, actuar, plotly, pracma

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**BugReports**  https://github.com/alan-turing-institute/distr6/issues

**VignetteBuilder**  knitr

**Encoding**  UTF-8

**RoxygenNote**  7.1.1

**SystemRequirements**  C++11

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LinkingTo Rcpp

NeedsCompilation yes

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distr6-package

distr6: Object Oriented Distributions in R

Description

distr6 is an object oriented (OO) interface, primarily used for interacting with probability distributions in R. Additionally distr6 includes functionality for composite distributions, a symbolic representation for mathematical sets and intervals, basic methods for common kernels and numeric methods for distribution analysis. distr6 is the official R6 upgrade to the distr family of packages.

Details

The main features of distr6 are:

- Currently implements 45 probability distributions (and 11 Kernels) including all distributions in the R stats package. Each distribution has (where possible) closed form analytic expressions for basic statistical methods.
- Decorators that add further functionality to probability distributions including numeric results for useful modelling functions such as p-norms and k-moments.
- Wrappers for composite distributions including convolutions, truncation, mixture distributions and product distributions.

To learn more about distr6, start with the distr6 vignette:

vignette("distr6","distr6")

And for more advanced usage see the complete tutorials at https://alan-turing-institute.github.io/distr6/index.html #nolint

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See Also

Useful links:
• https://alan-turing-institute.github.io/distr6/
• https://github.com/alan-turing-institute/distr6/
• Report bugs at https://github.com/alan-turing-institute/distr6/issues

---

### Arcsine

#### Arcsine Distribution Class

**Description**

Mathematical and statistical functions for the Arcsine distribution, which is commonly used in the study of random walks and as a special case of the Beta distribution.

**Details**

The Arcsine distribution parameterised with lower, \(a\), and upper, \(b\), limits is defined by the pdf,

\[
f(x) = \frac{1}{\pi \sqrt{(x - a)(b - x)}}
\]

for \(-\infty < a \leq b < \infty\).

**Value**

Returns an R6 object inheriting from class SDistribution.
Distribution support

The distribution is supported on \([a, b]\).

Default Parameterisation

Arc(lower = 0, upper = 1)

Omitted Methods

N/A

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> Arcsine

Public fields

- **name**  Full name of distribution.
- **short_name**  Short name of distribution for printing.
- **description**  Brief description of the distribution.

Methods

Public methods:

- Arcsine$new()
- Arcsine$mean()
- Arcsine$mode()
- Arcsine$variance()
- Arcsine$skewness()
- Arcsine$kurtosis()
- Arcsine$entropy()
- Arcsine$pgf()
- Arcsine$setParameterValue()
- Arcsine$clone()

**Method** new(): Creates a new instance of this **R6** class.

*Usage:*

Arcsine$new(lower = NULL, upper = NULL, decorators = NULL)

*Arguments:*

- **lower** (numeric(1))
  
  Lower limit of the **Distribution**, defined on the Reals.
upper (numeric(1))
    Upper limit of the Distribution, defined on the Reals.
decorators (character())
    Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution \(X\) is the expectation

\[
E_X(X) = \sum p_X(x) \cdot x
\]

with an integration analogue for continuous distributions.

Usage:
Arcsine$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Arcsine$mode(which = "all")

Arguments:
which (character(1) | numeric(1)
    Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula

\[
\text{var}_X = E[X^2] - E[X]^2
\]

where \(E_X\) is the expectation of distribution \(X\). If the distribution is multivariate the covariance matrix is returned.

Usage:
Arcsine$variance(...)

Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

\[
sk_X = E_X\left[\frac{x - \mu}{\sigma}\right]^3
\]

where \(E_X\) is the expectation of distribution \(X\), \(\mu\) is the mean of the distribution and \(\sigma\) is the standard deviation of the distribution.

Usage:
Arcsine$skewness(...)

Arguments:
... Unused.
Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
Arcsine$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))
If TRUE (default) excess kurtosis returned.
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by

\[-\sum(f_X)\log(f_X)\]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
Arcsine$entropy(base = 2, ...)

Arguments:
base (integer(1))
Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method pgf(): The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(z^x)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Arcsine$pgf(z, ...)

Arguments:
z (integer(1))
z integer to evaluate probability generating function at.
... Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
Arcsine$setParameterValue(
    ..., 
    lst = NULL, 
    error = "warn", 
    resolveConflicts = FALSE 
)
Arguments:

... ANY

Named arguments of parameters to set values for. See examples.

lst (list(1))

Alternative argument for passing parameters. List names should be parameter names and 
list values are the new values to set.

error (character(1))

If "warn" then returns a warning on error, otherwise breaks if "stop".

resolveConflicts (logical(1))

If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:

Arcsine$clone(deep = FALSE)

Arguments:

deep  Whether to make a deep clone.

References

Michael P. McLaughlin.

See Also

Other continuous distributions: BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, 
Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, 
Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, 
Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, 
Triangular, Uniform, Wald, Weibull

Other univariate distributions: Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, 
ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, 
FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, 
Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, 
NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, 
StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

as.data.table.ParameterSet

Coerce ParameterSet to data.table

Description

Coerces a ParameterSet to a data.table.
as.Distribution

Usage

```r
## S3 method for class 'ParameterSet'
as.data.table(x, ...)
```

Arguments

- `x` ParameterSet
- `...` Ignored.

Value

A data.table.

---

as.Distribution  Coerce matrix to vector of WeightedDiscrete

Description

Coerces matrices to a VectorDistribution containing WeightedDiscrete distributions. Number of distributions are the number of rows in the matrix, number of x points are number of columns in the matrix.

Usage

```r
as.Distribution(obj, fun, decorators = NULL)
```

Arguments

- `obj` matrix. Column names correspond to x in WeightedDiscrete, so this method only works if all distributions (rows in the matrix) have the same points to be evaluated on. Elements correspond to either the pdf or cdf of the distribution (see below).
- `fun` Either "pdf" or "cdf", passed to WeightedDiscrete and tells the constructor if the elements in obj correspond to the pdf or cdf of the distribution.
- `decorators` Passed to VectorDistribution.

Value

A VectorDistribution
Examples

```r
pdf <- runif(200)
mat <- matrix(pdf, 20, 10)
mat <- t(apply(mat, 1, function(x) x / sum(x)))
colnames(mat) <- 1:10
as.Distribution(mat, fun = "pdf")
```

---

as.MixtureDistribution

**Coercion to Mixture Distribution**

Description

Helper functions to quickly convert compatible objects to a MixtureDistribution.

Usage

```r
as.MixtureDistribution(object, weights = "uniform")
```

Arguments

object: ProductDistribution or VectorDistribution
weights: (character(1)|numeric())
Weights to use in the resulting mixture. If all distributions are weighted equally then "uniform" provides a much faster implementation, otherwise a vector of length equal to the number of wrapped distributions, this is automatically scaled internally.

---

as.ParameterSet

**Coerce to a ParameterSet**

Description

Coerces objects to ParameterSet.

Usage

```r
as.ParameterSet(x,...)
```

## S3 method for class 'data.table'

```r
as.ParameterSet(x,...)
```

## S3 method for class 'list'

```r
as.ParameterSet(x,...)
```
Arguments

x  object
... additional arguments

Details
Currently supported coercions are from data tables and lists. Function assumes that the data table columns are the correct inputs to a ParameterSet, see the constructor for details. Similarly for lists, names are taken to be ParameterSet parameters and values taken to be arguments.

Value
An R6 object of class ParameterSet.

See Also
ParameterSet

as.ProductDistribution

Description
Helper functions to quickly convert compatible objects to a ProductDistribution.

Usage
as.ProductDistribution(object)

Arguments

object  MixtureDistribution or VectorDistribution

as.VectorDistribution

Description
Helper functions to quickly convert compatible objects to a VectorDistribution.

Usage
as.VectorDistribution(object)

Arguments

object  MixtureDistribution or ProductDistribution
Bernoulli Distribution Class

Description
Mathematical and statistical functions for the Bernoulli distribution, which is commonly used to model a two-outcome scenario.

Details
The Bernoulli distribution parameterised with probability of success, \( p \), is defined by the pmf,

\[
\begin{align*}
  f(x) &= p, \text{ if } x = 1 \\
  f(x) &= 1 - p, \text{ if } x = 0
\end{align*}
\]

for probability \( p \).

Value
Returns an R6 object inheriting from class SDistribution.

Distribution support
The distribution is supported on \( \{0, 1\} \).

Default Parameterisation
Bern(prob = 0.5)

Omitted Methods
N/A

Also known as
N/A

Super classes
distr6::Distribution -> distr6::SDistribution -> Bernoulli

Public fields
name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.
packages  Packages required to be installed in order to construct the distribution.
Methods

Public methods:

- Bernoulli$new()
- Bernoulli$mean()
- Bernoulli$mode()
- Bernoulli$median()
- Bernoulli$variance()
- Bernoulli$skewness()
- Bernoulli$kurtosis()
- Bernoulli$entropy()
- Bernoulli$mgf()
- Bernoulli$cf()
- Bernoulli$pgf()
- Bernoulli$setParameterValue()
- Bernoulli$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Bernoulli$new(prob = NULL, qprob = NULL, decorators = NULL)

Arguments:
prob (numeric(1))
  Probability of success.
qprob (numeric(1))
  Probability of failure. If provided then prob is ignored. qprob = 1 -prob.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) * x \]

with an integration analogue for continuous distributions.

Usage:
Bernoulli$mean(...) 

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Bernoulli$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
     Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies
     which mode to return.

Method median(): Returns the median of the distribution. If an analytical expression is avail-
     able returns distribution median, otherwise if symmetric returns self$mean, otherwise returns
     self$quantile(0.5).
Usage:
Bernoulli$median()

Method variance(): The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance
     matrix is returned.
Usage:
Bernoulli$variance(...)
Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised mo-
     ment,

\[ \text{sk}_X = E_X \left[ \frac{x - \mu}{\sigma}^3 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the
     standard deviation of the distribution.
Usage:
Bernoulli$skewness(...)
Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised mo-
     ment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma}^4 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the
     standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.
Usage:
Bernoulli$kurtosis(excess = TRUE, ...)
Arguments:
excess (logical(1))
     If TRUE (default) excess kurtosis returned.
... Unused.
Method `entropy()`: The entropy of a (discrete) distribution is defined by

\[- \sum (f_X) \log(f_X)\]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
Bernoulli$entropy(base = 2, \ldots)

Arguments:
base (integer(1))
  Base of the entropy logarithm, default = 2 (Shannon entropy)
\ldots Unused.

Method `mgf()`: The moment generating function is defined by

\[ mgf_X(t) = E_X[\exp(xt)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Bernoulli$mgf(t, \ldots)

Arguments:
t (integer(1))
  t integer to evaluate function at.
\ldots Unused.

Method `cf()`: The characteristic function is defined by

\[ cf_X(t) = E_X[\exp(xti)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Bernoulli$cf(t, \ldots)

Arguments:
t (integer(1))
  t integer to evaluate function at.
\ldots Unused.

Method `pgf()`: The probability generating function is defined by

\[ pgf_X(z) = E_X[\exp(z^x)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Bernoulli$pgf(z, \ldots)

Arguments:
z (integer(1))
  z integer to evaluate probability generating function at.
Method `setParameterValue()`: Sets the value(s) of the given parameter(s).

Usage:
Bernoulli$setParameterValue(
  ..., 
  lst = NULL, 
  error = "warn", 
  resolveConflicts = FALSE
)

Arguments:
  ... ANY
    Named arguments of parameters to set values for. See examples.
  lst (list(1))
    Alternative argument for passing parameters. List names should be parameter names and
    list values are the new values to set.
  error (character(1))
    If "warn" then returns a warning on error, otherwise breaks if "stop".
  resolveConflicts (logical(1))
    If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
    tomatically resolves them by removing all conflicting parameters.

Method `clone()`: The objects of this class are cloneable with this method.

Usage:
Bernoulli$clone(deep = FALSE)

Arguments:
  deep  Whether to make a deep clone.

References

Michael P. McLaughlin.

See Also

Other discrete distributions: Binomial, Categorical, Degenerate, DiscreteUniform, EmpiricalMV,
Empirical, Geometric, Hypergeometric, Logarithmic, Multinomial, NegativeBinomial, WeightedDiscrete

Other univariate distributions: Arcsine, BetaNoncentral, Beta, Binomial, Categorical, Cauchy,
ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential,
FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel,
Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal,
NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral,
StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete
Beta Distribution Class

Description

Mathematical and statistical functions for the Beta distribution, which is commonly used as the prior in Bayesian modelling.

Details

The Beta distribution parameterised with two shape parameters, $\alpha, \beta$, is defined by the pdf,

$$f(x) = \frac{x^{\alpha-1}(1-x)^{\beta-1}}{B(\alpha, \beta)}$$

for $\alpha, \beta > 0$, where $B$ is the Beta function.

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on $[0, 1]$.

Default Parameterisation

Beta(shape1 = 1, shape2 = 1)

Omitted Methods

N/A

Also known as

N/A

Super classes

\texttt{distr6::Distribution -> distr6::SDistribution -> Beta}

Public fields

name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.
Methods

Public methods:

- Beta$new()
- Beta$mean()
- Beta$mode()
- Beta$variance()
- Beta$skewness()
- Beta$kurtosis()
- Beta$entropy()
- Beta$pgf()
- Beta$setParameterValue()
- Beta$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Beta$new(shape1 = NULL, shape2 = NULL, decorators = NULL)

Arguments:
shape1 (numeric(1))
  First shape parameter, shape1 > 0.
shape2 (numeric(1))
  Second shape parameter, shape2 > 0.
dercorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) \times x \]

with an integration analogue for continuous distributions.

Usage:
Beta$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Beta$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
  Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.
**Method variance():** The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

*Usage:*

`Beta$variance(...)`

*Arguments:*

... Unused.

**Method skewness():** The skewness of a distribution is defined by the third standardised moment,

\[ \text{sk}_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

*Usage:*

`Beta$skewness(...)`

*Arguments:*

... Unused.

**Method kurtosis():** The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

*Usage:*

`Beta$kurtosis(\text{excess} = \text{TRUE}, \ldots)`

*Arguments:*

\text{excess} (logical(1))

If \text{TRUE} (default) excess kurtosis returned.

... Unused.

**Method entropy():** The entropy of a (discrete) distribution is defined by

\[ -\sum (f_X) \log(f_X) \]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

*Usage:*

`Beta$entropy(\text{base} = 2, \ldots)`

*Arguments:*

\text{base} (integer(1))

Base of the entropy logarithm, default = 2 (Shannon entropy)
Method `pgf()`: The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(z^x)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:

Beta$pgf(z, \ldots)$

Arguments:

- \( z \) (integer(1))
  - \( z \) integer to evaluate probability generating function at.
  - ... Unused.

Method `setParameterValue()`: Sets the value(s) of the given parameter(s).

Usage:

Beta$setParameterValue(
  ..., 
  lst = NULL,
  error = "warn",
  resolveConflicts = FALSE
)

Arguments:

- ANY
  - Named arguments of parameters to set values for. See examples.
- lst (list(1))
  - Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.
- error (character(1))
  - If "warn" then returns a warning on error, otherwise breaks if "stop".
- resolveConflicts (logical(1))
  - If FALSE (default) throws error if conflicting parameterisations are provided, otherwise automatically resolves them by removing all conflicting parameters.

Method `clone()`: The objects of this class are cloneable with this method.

Usage:

Beta$clone(deep = FALSE)

Arguments:

- deep Whether to make a deep clone.

References

BetaNoncentral

See Also

Other continuous distributions: Arcsine, BetaNoncentral, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

<table>
<thead>
<tr>
<th>BetaNoncentral</th>
<th>Noncentral Beta Distribution Class</th>
</tr>
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Description

Mathematical and statistical functions for the Noncentral Beta distribution, which is commonly used as the prior in Bayesian modelling.

Details

The Noncentral Beta distribution parameterised with two shape parameters, \( \alpha, \beta \), and location, \( \lambda \), is defined by the pdf,

\[
f(x) = \exp\left(-\lambda/2\right) \sum_{r=0}^{\infty} \frac{(\lambda/2)^r}{r!}(x^{\alpha+r-1}(1-x)^{\beta-1})/B(\alpha + r, \beta)
\]

for \( \alpha, \beta > 0, \lambda \geq 0 \), where \( B \) is the Beta function.

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on \([0, 1]\).

Default Parameterisation

BetaNC(shape1 = 1, shape2 = 1, location = 0)

Omitted Methods

N/A
Also known as
N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> BetaNoncentral

Public fields

name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.

Methods

Public methods:

• BetaNoncentral$new()
• BetaNoncentral$setParameterValue()
• BetaNoncentral$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
BetaNoncentral$new(
    shape1 = NULL,
    shape2 = NULL,
    location = NULL,
    decorators = NULL
)

Arguments:

shape1 (numeric(1))
    First shape parameter, shape1 > 0.
shape2 (numeric(1))
    Second shape parameter, shape2 > 0.
location (numeric(1))
    Location parameter, defined on the non-negative Reals.
decorators (character())
    Decorators to add to the distribution during construction.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
BetaNoncentral$setParameterValue(
    ...,
    lst = NULL,
    error = "warn",
    resolveConflicts = FALSE
)
Arguments:

... ANY
    Named arguments of parameters to set values for. See examples.
lst (list(1))
    Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.
error (character(1))
    If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
    If FALSE (default) throws error if conflicting parameterisations are provided, otherwise automatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
BetaNoncentral$clone(deep = FALSE)

Arguments:

deep  Whether to make a deep clone.

Author(s)

Jordan Deenichin

References


See Also

Other continuous distributions: Arcsine, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete
Description

Mathematical and statistical functions for the Binomial distribution, which is commonly used to model the number of successes out of a number of independent trials.

Details

The Binomial distribution parameterised with number of trials, n, and probability of success, p, is defined by the pmf,

\[ f(x) = \binom{n}{x} p^x (1 - p)^{n-x} \]

for \( n = 0, 1, 2, \ldots \) and probability \( p \), where \( \binom{a}{b} \) is the combination (or binomial coefficient) function.

Value

Returns an R6 object inheriting from class `SDistribution`.

Distribution support

The distribution is supported on \( 0, 1, \ldots, n \).

Default Parameterisation

`Binom(size = 10, prob = 0.5)`

Omitted Methods

N/A

Also known as

N/A

Super classes

`distr6::Distribution -> distr6::SDistribution -> Binomial`

Public fields

- `name` Full name of distribution.
- `short_name` Short name of distribution for printing.
- `description` Brief description of the distribution.
- `packages` Packages required to be installed in order to construct the distribution.
Methods

Public methods:
• Binomial$new()
• Binomial$mean()
• Binomial$mode()
• Binomial$variance()
• Binomial$skewness()
• Binomial$kurtosis()
• Binomial$entropy()
• Binomial$mgf()
• Binomial$cf()
• Binomial$pgf()
• Binomial$setParameterValue()
• Binomial$clone()

Method new(): Creates a new instance of this R6 class.
Usage:
Binomial$new(size = NULL, prob = NULL, qprob = NULL, decorators = NULL)

Arguments:
size (integer(1))
  Number of trials, defined on the positive Naturals.
prob (numeric(1))
  Probability of success.
qprob (numeric(1))
  Probability of failure. If provided then prob is ignored. qprob = 1 - prob.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) \cdot x \]

with an integration analogue for continuous distributions.
Usage:
Binomial$mean(\ldots)

Arguments:
\ldots Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).
Usage:
Binomial$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
Ignored if distribution is unimodal. Otherwise “all” returns all modes, otherwise specifies which mode to return.

**Method variance():** The variance of a distribution is defined by the formula

\[ var_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

**Usage:**

Binomial$variance(...)

**Arguments:**

... Unused.

**Method skewness():** The skewness of a distribution is defined by the third standardised moment,

\[ sk_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

**Usage:**

Binomial$skewness(...)

**Arguments:**

... Unused.

**Method kurtosis():** The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

**Usage:**

Binomial$kurtosis(excess = TRUE, ...)

**Arguments:**

excess (logical(1))
If TRUE (default) excess kurtosis returned.
... Unused.

**Method entropy():** The entropy of a (discrete) distribution is defined by

\[ - \sum (f_X) \log(f_X) \]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

**Usage:**

Binomial$entropy(base = 2, ...)
Binomial

Arguments:
base (integer(1))
   Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method mgf(): The moment generating function is defined by

$$mgf_X(t) = E_X[exp(xt)]$$

where X is the distribution and $E_X$ is the expectation of the distribution X.

Usage:
Binomial$mgf(t, ...)

Arguments:
t (integer(1))
   t integer to evaluate function at.
... Unused.

Method cf(): The characteristic function is defined by

$$cf_X(t) = E_X[exp(xti)]$$

where X is the distribution and $E_X$ is the expectation of the distribution X.

Usage:
Binomial$cf(t, ...)

Arguments:
t (integer(1))
   t integer to evaluate function at.
... Unused.

Method pgf(): The probability generating function is defined by

$$pgf_X(z) = E_X[exp(z^x)]$$

where X is the distribution and $E_X$ is the expectation of the distribution X.

Usage:
Binomial$pgf(z, ...)

Arguments:
z (integer(1))
   z integer to evaluate probability generating function at.
... Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
Binomial$setParameterValue(
   ..., 
   lst = NULL,
   error = "warn",
   resolveConflicts = FALSE
)
Arguments:

... ANY
   Named arguments of parameters to set values for. See examples.
lst (list(1))
   Alternative argument for passing parameters. List names should be parameter names and
   list values are the new values to set.
error (character(1))
   If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
   If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
   tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Binomial$clone(deep = FALSE)

Arguments:
   deep Whether to make a deep clone.

References
Michael P. McLaughlin.

See Also
Other discrete distributions: Bernoulli, Categorical, Degenerate, DiscreteUniform, EmpiricalMV,
Empirical, Geometric, Hypergeometric, Logarithmic, Multinomial, NegativeBinomial, WeightedDiscrete
Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Categorical, Cauchy,
ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential,
FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel,
Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal,
NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral,
StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

---

c.Distribution Combine Distributions into a VectorDistribution

Description
Helper function for quickly combining distributions into a VectorDistribution.

Usage
## S3 method for class 'Distribution'
c(..., name = NULL, short_name = NULL, decorators = NULL)
Arguments

... distributions to be concatenated.
name, short_name, decorators

See VectorDistribution

Value

A VectorDistribution

See Also

VectorDistribution

Examples

# Construct and combine
c(Binomial$new(), Normal$new())

# More complicated distributions
b <- truncate(Binomial$new(), 2, 6)
n <- huberize(Normal$new(), -1, 1)
c(b, n)

# Concatenate VectorDistributions
v1 <- VectorDistribution$new(list(Binomial$new(), Normal$new()))
v2 <- VectorDistribution$new(
  distribution = "Gamma",
  params = data.table::data.table(shape = 1:2, rate = 1:2)
)
c(v1, v2)

Description

Mathematical and statistical functions for the Categorical distribution, which is commonly used in classification supervised learning.

Details

The Categorical distribution parameterised with a given support set, \( x_1, \ldots, x_k \), and respective probabilities, \( p_1, \ldots, p_k \), is defined by the pmf,

\[
\hat{f}(x_i) = p_i
\]

for \( p_i, i = 1, \ldots, k; \sum p_i = 1 \).

Sampling from this distribution is performed with the sample function with the elements given as the support set and the probabilities from the probs parameter. The cdf and quantile assumes that the elements are supplied in an indexed order (otherwise the results are meaningless).

The number of points in the distribution cannot be changed after construction.
Value
Returns an R6 object inheriting from class SDistribution.

Distribution support
The distribution is supported on $x_1, ..., x_k$.

Default Parameterisation
Cat(elements = 1, probs = 1)

Omitted Methods
N/A

Also known as
N/A

Super classes
distr6::Distribution -> distr6::SDistribution -> Categorical

Public fields
name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.

Methods

Public methods:
• Categorical$new()
• Categorical$mean()
• Categorical$mode()
• Categorical$variance()
• Categorical$skewness()
• Categorical$kurtosis()
• Categorical$entropy()
• Categorical$mgf()
• Categorical$cf()
• Categorical$pgf()
• Categorical$setParameterValue()
• Categorical$clone()

Method new(): Creates a new instance of this R6 class.
Usage:
Categorical$new(elements = NULL, probs = NULL, decorators = NULL)

**Arguments:**
elements list()
   Categories in the distribution, see examples.
probs numeric()
   Probabilities of respective categories occurring.
decorators (character())
   Decorators to add to the distribution during construction.

**Examples:**
# Note probabilities are automatically normalised (if not vectorised)
x <- Categorical$new(elements = list("Bapple", "Banana", 2), probs = c(0.2, 0.4, 1))

# Length of elements and probabilities cannot be changed after construction
x$setParameterValue(probs = c(0.1, 0.2, 0.7))

# d/p/q/r
x$pdf(c("Bapple", "Carrot", 1, 2))
x$cdf("Banana") # Assumes ordered in construction
x$quantile(0.42) # Assumes ordered in construction
x$rand(10)

# Statistics
x$mode()
summary(x)

**Method** `mean()`: The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

\[
E_X(X) = \sum p_X(x) * x
\]

with an integration analogue for continuous distributions.

**Usage:**
Categorical$mean(...)

**Arguments:**
... Unused.

**Method** `mode()`: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

**Usage:**
Categorical$mode(which = "all")

**Arguments:**
which (character(1) | numeric(1))
   Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.
**Method variance():** The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

*Usage:*
Categorical$variance(...)  
*Arguments:*
... Unused.

**Method skewness():** The skewness of a distribution is defined by the third standardised moment,

\[ \text{sk}_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]

where \( E_X \) is the expectation of distribution X, \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

*Usage:*
Categorical$skewness(...)  
*Arguments:*
... Unused.

**Method kurtosis():** The kurtosis of a distribution is defined by the fourth standardised moment,

\[ \text{k}_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]

where \( E_X \) is the expectation of distribution X, \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

*Usage:*
Categorical$kurtosis(excess = TRUE, ...)
*Arguments:*
excess (logical(1))  
If TRUE (default) excess kurtosis returned.  
... Unused.

**Method entropy():** The entropy of a (discrete) distribution is defined by

\[ - \sum (f_X) \log(f_X) \]

where \( f_X \) is the pdf of distribution X, with an integration analogue for continuous distributions.

*Usage:*
Categorical$entropy(base = 2, ...)
*Arguments:*
base (integer(1))  
Base of the entropy logarithm, default = 2 (Shannon entropy)
Method mgf(): The moment generating function is defined by

$$mgf_X(t) = E_X[exp(xt)]$$

where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$.

Usage:

Categorical$mgf(t, ...)

Arguments:

t (integer(1))
    t integer to evaluate function at.

... Unused.

Method cf(): The characteristic function is defined by

$$cf_X(t) = E_X[exp(xti)]$$

where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$.

Usage:

Categorical$cf(t, ...)

Arguments:

t (integer(1))
    t integer to evaluate function at.

... Unused.

Method pgf(): The probability generating function is defined by

$$pgf_X(z) = E_X[exp(z^x)]$$

where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$.

Usage:

Categorical$pgf(z, ...)

Arguments:

z (integer(1))
    z integer to evaluate probability generating function at.

... Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:

Categorical$setParameterValue(
    ...,
    lst = NULL,
    error = "warn",
    resolveConflicts = FALSE
)
Arguments:

... ANY

Named arguments of parameters to set values for. See examples.

lst (list())

Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.

error (character(1))

If "warn" then returns a warning on error, otherwise breaks if "stop".

resolveConflicts (logical(1))

If FALSE (default) throws error if conflicting parameterisations are provided, otherwise automatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Categorical$clone(deep = FALSE)

Arguments:

dep  Whether to make a deep clone.

References


See Also

Other discrete distributions: Bernoulli, Binomial, Degenerate, DiscreteUniform, EmpiricalMV, Empirical, Geometric, Hypergeometric, Logarithmic, Multinomial, NegativeBinomial, WeightedDiscrete

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

Examples

```
# Method `Categorical$new`
# -----------------------------------------------
# Note probabilities are automatically normalised (if not vectorised)
x <- Categorical$new(elements = list("Bapple", "Banana", 2), probs = c(0.2, 0.4, 1))

# Length of elements and probabilities cannot be changed after construction
x$setParameterValue(probs = c(0.1, 0.2, 0.7))

# d/p/q/r
```
Cauchy

Cauchy

Cauchy Distribution Class

Description
Mathematical and statistical functions for the Cauchy distribution, which is commonly used in physics and finance.

Details
The Cauchy distribution parameterised with location, \( \alpha \), and scale, \( \beta \), is defined by the pdf,

\[
f(x) = \frac{1}{\pi \beta (1 + ((x - \alpha) / \beta)^2)}
\]

for \( \alpha \in \mathbb{R} \) and \( \beta > 0 \).

Value
Returns an R6 object inheriting from class SDistribution.

Distribution support
The distribution is supported on the Reals.

Default Parameterisation
Cauchy(location = 0, scale = 1)

Omitted Methods
N/A

Also known as
N/A

Super classes
\[ \text{distr6::Distribution} \rightarrow \text{distr6::SDistribution} \rightarrow \text{Cauchy} \]
Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.
packages  Packages required to be installed in order to construct the distribution.

Methods

Public methods:

• Cauchy$new()
• Cauchy$mean()
• Cauchy$mode()
• Cauchy$variance()
• Cauchy$skewness()
• Cauchy$kurtosis()
• Cauchy$entropy()
• Cauchy$mgf()
• Cauchy$cf()
• Cauchy$pgf()
• Cauchy$clone()

Method new(): Creates a new instance of this R6 class.
Usage:
Cauchy$new(location = NULL, scale = NULL, decorators = NULL)
Arguments:
location (numeric(1))
  Location parameter defined on the Reals.
scale (numeric(1))
  Scale parameter defined on the positive Reals.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) * x \]

with an integration analogue for continuous distributions.
Usage:
Cauchy$mean(...)
Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).
Usage:
Cauchy$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
    Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
Cauchy$variance(...)

Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

\[ \text{sk}_X = E_X \left[ \frac{x - \mu}{\sigma}^3 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
Cauchy$skewness(...)

Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma}^4 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
Cauchy$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))
    If TRUE (default) excess kurtosis returned.
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by

\[ - \sum (f_X) \log(f_X) \]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.
Usage:
Cauchy$entropy(base = 2, ...)

Arguments:
  base (integer(1))
    Base of the entropy logarithm, default = 2 (Shannon entropy)
  ...
    Unused.

Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X[exp(xt)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X.

Usage:
Cauchy$mgf(t, ...)

Arguments:
  t (integer(1))
    t integer to evaluate function at.
  ...
    Unused.

Method cf(): The characteristic function is defined by

\[ cf_X(t) = E_X[exp(xti)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X.

Usage:
Cauchy$cf(t, ...)

Arguments:
  t (integer(1))
    t integer to evaluate function at.
  ...
    Unused.

Method pgf(): The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(zx)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X.

Usage:
Cauchy$pgf(z, ...)

Arguments:
  z (integer(1))
    z integer to evaluate probability generating function at.
  ...
    Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Cauchy$clone(deep = FALSE)

Arguments:
  deep  Whether to make a deep clone.
Author(s)
Chijing Zeng

References

See Also
Other continuous distributions: Arcsine, BetaNoncentral, Beta, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull
Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

cdf

Cumulative Distribution Function

Description
See Distribution$cdf

Usage
cdf(object, ..., lower.tail = TRUE, log.p = FALSE, simplify = TRUE, data = NULL)

Arguments
object (Distribution)
... (numeric())
Points to evaluate the cumulative distribution function of the distribution. Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.
lower.tail logical(1)
If TRUE (default), probabilities are X <= x, otherwise, X > x.
log.p logical(1)
If TRUE returns log-cdf. Default is FALSE.
cdfAntiDeriv

simplify logical(1)
If TRUE (default) simplifies the pdf if possible to a numeric, otherwise returns a
data.table::data.table.
data array
Alternative method to specify points to evaluate. If univariate then rows corre-
spond with number of points to evaluate and columns correspond with number
of variables to evaluate. In the special case of VectorDistributions of multivari-
ate distributions, then the third dimension corresponds to the distribution in the
vector to evaluate.

Value
Cdf evaluated at given points as either a numeric if simplify is TRUE or as a data.table::data.table.

cdfAntiDeriv  Cumulative Distribution Function Anti-Derivative

Description
The anti-derivative of the cumulative distribution function between given limits or over the full
support.

Usage
cdfAntiDeriv(object, lower = NULL, upper = NULL)

Arguments
object Distribution.
lower  lower limit for integration, default is infimum.
upper  upper limit for integration, default is supremum.

Value
Antiderivative of the cdf evaluated between limits as a numeric.
**cdfPNorm**  
*Cumulative Distribution Function P-Norm*

**Description**  
The p-norm of the cdf evaluated between given limits or over the whole support.

**Usage**  
cdfPNorm(object, p = 2, lower = NULL, upper = NULL)

**Arguments**  
- **object**: Distribution.
- **p**: p-norm to calculate.
- **lower**: lower limit for integration, default is infimum.
- **upper**: upper limit for integration, default is supremum.

**Value**  
Given p-norm of cdf evaluated between limits as a numeric.

---

**cdfSquared2Norm**  
*Squared Cumulative Distribution Function 2-Norm*

**Description**  
The squared 2-norm of the cdf evaluated up to a given limit, possibly shifted.

**Usage**  
cdfSquared2Norm(object, x = 0, upper = Inf)

**Arguments**  
- **object**: Distribution.
- **x**: amount to shift the result.
- **upper**: upper limit of the integral.

**Value**  
Squared 2-norm of cdf evaluated between limits as a numeric.
### cf

*Characteristic Function*

#### Description

Characteristic function of a distribution

#### Usage

```r
cf(object, t, ...)
```

#### Arguments

- **object**: Distribution.
- **t**: integer to evaluate characteristic function at.
- **...**: Passed to `genExp`.

#### Value

Characteristic function evaluated at `t` as a numeric.

---

### ChiSquared

*Chi-Squared Distribution Class*

#### Description

Mathematical and statistical functions for the Chi-Squared distribution, which is commonly used to model the sum of independent squared Normal distributions and for confidence intervals.

#### Details

The Chi-Squared distribution parameterised with degrees of freedom, \( \nu \), is defined by the pdf,

\[
f(x) = \frac{x^{\nu/2-1} \exp(-x/2)}{(2^{\nu/2} \Gamma(\nu/2))}
\]

for \( \nu > 0 \).

#### Value

Returns an R6 object inheriting from class `SDistribution`.

#### Distribution support

The distribution is supported on the Positive Reals.
**ChiSquared**

**Default Parameterisation**
ChiSq(df = 1)

**Omitted Methods**
N/A

**Also known as**
N/A

**Super classes**

distr6::Distribution -> distr6::SDistribution -> ChiSquared

**Public fields**

- name  Full name of distribution.
- short_name  Short name of distribution for printing.
- description  Brief description of the distribution.
- packages  Packages required to be installed in order to construct the distribution.

**Methods**

**Public methods:**

- ChiSquared$new()
- ChiSquared$mean()
- ChiSquared$mode()
- ChiSquared$variance()
- ChiSquared$skewness()
- ChiSquared$kurtosis()
- ChiSquared$entropy()
- ChiSquared$mgf()
- ChiSquared$cf()
- ChiSquared$pgf()
- ChiSquared$setParameterValue()
- ChiSquared$clone()

**Method new():** Creates a new instance of this R6 class.

*Usage:*
ChiSquared$new(df = NULL, decorators = NULL)

*Arguments:*
- df (integer(1))
  Degrees of freedom of the distribution defined on the positive Reals.
decorators (character())

Decorators to add to the distribution during construction.

**Method mean()**: The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

$$E_X(X) = \sum p_X(x) \cdot x$$

with an integration analogue for continuous distributions.

*Usage:*

ChiSquared$mean(...)

*Arguments:*

... Unused.

**Method mode()**: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

*Usage:*

ChiSquared$mode(which = "all")

*Arguments:*

which (character(1) | numeric(1))

Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

**Method variance()**: The variance of a distribution is defined by the formula

$$var_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution $X$. If the distribution is multivariate the covariance matrix is returned.

*Usage:*

ChiSquared$variance(...)

*Arguments:*

... Unused.

**Method skewness()**: The skewness of a distribution is defined by the third standardised moment,

$$sk_X = E_X\left[\frac{x - \mu}{\sigma}^3\right]$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution.

*Usage:*

ChiSquared$skewness(...)

*Arguments:*

... Unused.
**Method** kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma}^4 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

*Usage:*

ChiSquared$kurtosis(excess = TRUE, ...)

*Arguments:*

- **excess** (logical(1))
  - If TRUE (default) excess kurtosis returned.
- ... Unused.

**Method** entropy(): The entropy of a (discrete) distribution is defined by

\[ -\sum (f_X) \log(f_X) \]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

*Usage:*

ChiSquared$entropy(base = 2, ...)

*Arguments:*

- **base** (integer(1))
  - Base of the entropy logarithm, default = 2 (Shannon entropy)
- ... Unused.

**Method** mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X [\exp(xt)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

*Usage:*

ChiSquared$mgf(t, ...)

*Arguments:*

- **t** (integer(1))
  - \( t \) integer to evaluate function at.
- ... Unused.

**Method** cf(): The characteristic function is defined by

\[ cf_X(t) = E_X [\exp(xti)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

*Usage:*

ChiSquared$cf(t, ...)

*Arguments:*

Method \texttt{pgf()}: The probability generating function is defined by
\[ pgf_X(z) = E_X[exp(z^X)] \]
where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
\texttt{ChiSquared$pgf(z, \ldots)}

Arguments:
- \( z \) (integer(1))
  - \( z \) integer to evaluate probability generating function at.
  - ... Unused.

Method \texttt{setParameterValue()}: Sets the value(s) of the given parameter(s).

Usage:
\texttt{ChiSquared$setParameterValue(..., lst = NULL, error = "warn", resolveConflicts = FALSE)}

Arguments:
- ... ANY
  - Named arguments of parameters to set values for. See examples.
- lst (list(1))
  - Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.
- error (character(1))
  - If "warn" then returns a warning on error, otherwise breaks if "stop".
- resolveConflicts (logical(1))
  - If FALSE (default) throws error if conflicting parameterisations are provided, otherwise automatically resolves them by removing all conflicting parameters.

Method \texttt{clone()}: The objects of this class are cloneable with this method.

Usage:
\texttt{ChiSquared$clone(deep = FALSE)}

Arguments:
- deep Whether to make a deep clone.

References

See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

---

ChiSquaredNoncentral

Noncentral Chi-Squared Distribution Class

Description

Mathematical and statistical functions for the Noncentral Chi-Squared distribution, which is commonly used to model the sum of independent squared Normal distributions and for confidence intervals.

Details

The Noncentral Chi-Squared distribution parameterised with degrees of freedom, \( \nu \), and location, \( \lambda \), is defined by the pdf,

\[
f(x) = \exp\left(-\frac{\lambda}{2}\right) \sum_{r=0}^{\infty} \left(\frac{\lambda}{2}\right)^r r! \left(x^{(\nu+2r)/2} - 1\right) \exp\left(-\frac{x}{2}\right) / \left(2^{(\nu+2r)/2} \Gamma\left(\frac{\nu+2r}{2}\right)\right)
\]

for \( \nu \geq 0, \lambda \geq 0 \).

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on the Positive Reals.

Default Parameterisation

ChiSqNC(df = 1, location = 0)

Omitted Methods

N/A
Also known as
N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> ChiSquaredNoncentral

Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.
packages  Packages required to be installed in order to construct the distribution.

Methods

Public methods:
• ChiSquaredNoncentral$new()
• ChiSquaredNoncentral$mean()
• ChiSquaredNoncentral$variance()
• ChiSquaredNoncentral$skewness()
• ChiSquaredNoncentral$kurtosis()
• ChiSquaredNoncentral$mgf()
• ChiSquaredNoncentral$cf()
• ChiSquaredNoncentral$setParameterValue()
• ChiSquaredNoncentral$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
ChiSquaredNoncentral$new(df = NULL, location = NULL, decorators = NULL)

Arguments:
df (integer(1))
  Degrees of freedom of the distribution defined on the positive Reals.
location (numeric(1))
  Location parameter, defined on the non-negative Reals.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) \cdot x \]

with an integration analogue for continuous distributions.

Usage:
ChiSquaredNoncentral$mean(...)
Method variance(): The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
ChiSquaredNoncentral$variance(...)  
Arguments:  
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

\[ \text{sk}_X = E_X \left( \frac{x - \mu}{\sigma} \right)^3 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
ChiSquaredNoncentral$skewness(...)  
Arguments:  
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left( \frac{x - \mu}{\sigma} \right)^4 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
ChiSquaredNoncentral$kurtosis(excess = TRUE, ...)
Arguments:  
excess (logical(1))  
If TRUE (default) excess kurtosis returned.  
... Unused.

Method mgf(): The moment generating function is defined by

\[ \text{mgf}_X(t) = E_X[exp(xt)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
ChiSquaredNoncentral$mgf(t, ...)
Arguments:
Method cf(): The characteristic function is defined by

\[ cf_X(t) = E_X[exp(xt)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X.

Usage:
ChiSquaredNoncentral$cf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
  ... Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
ChiSquaredNoncentral$setParameterValue(
  ..., 
  lst = NULL, 
  error = "warn", 
  resolveConflicts = FALSE
)

Arguments:
... ANY
  Named arguments of parameters to set values for. See examples.
lst (list(1))
  Alternative argument for passing parameters. List names should be parameter names and
  list values are the new values to set.
error (character(1))
  If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
  If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
  tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
ChiSquaredNoncentral$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

Author(s)
Jordan Deenichin
Convolution

References


See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

---

Convolution Distribution Convolution Wrapper

Description

Calculates the convolution of two distributions via numerical calculations.

Usage

```r
## S3 method for class 'Distribution'
+ x + y

## S3 method for class 'Distribution'
- x - y
```

Arguments

- `x`, `y` Distribution

Details

The convolution of two probability distributions $X, Y$ is the sum

$$Z = X + Y$$

which has a pmf,

$$P(Z = z) = \sum_x P(X = x) P(Y = z - x)$$

with an integration analogue for continuous distributions.

Currently distr6 supports the addition of discrete and continuous probability distributions, but only subtraction of continuous distributions.
Value

Returns an R6 object of class Convolution.

Super classes

distr6::Distribution -> distr6::DistributionWrapper -> Convolution

Methods

Public methods:

• Convolution$new()
• Convolution$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Convolution$new(dist1, dist2, add = TRUE)

Arguments:

dist1 ([Distribution])
  First Distribution in convolution, i.e. dist1 ± dist2.

dist2 ([Distribution])
  Second Distribution in convolution, i.e. dist1 ± dist2.

add (logical(1))
  If TRUE (default) then adds the distributions together, otherwise substracts.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Convolution$clone(deep = FALSE)

Arguments:

deep  Whether to make a deep clone.

See Also

Other wrappers: DistributionWrapper, HuberizedDistribution, MixtureDistribution, ProductDistribution, TruncatedDistribution, VectorDistribution

Examples

binom <- Bernoulli$new() + Bernoulli$new()
binom$pdf(2)
Binomial$new(size = 2)$pdf(2)
norm <- Normal$new(mean = 3) - Normal$new(mean = 2)
norm$pdf(1)
Normal$new(mean = 1, var = 2)$pdf(1)
Description

This decorator adds numeric methods for missing analytic expressions in distributions as well as adding generalised expectation and moments functions.

Details

Decorator objects add functionality to the given Distribution object by copying methods in the decorator environment to the chosen Distribution environment.

All methods implemented in decorators try to exploit analytical results where possible, otherwise numerical results are used with a message.

Super class

distr6::DistributionDecorator -> CoreStatistics

Methods

Public methods:

- CoreStatistics$mgf()
- CoreStatistics$cf()
- CoreStatistics$pgf()
- CoreStatistics$entropy()
- CoreStatistics$skewness()
- CoreStatistics$kurtosis()
- CoreStatistics$variance()
- CoreStatistics$kthmoment()
- CoreStatistics$genExp()
- CoreStatistics$mode()
- CoreStatistics$mean()
- CoreStatistics$clone()

Method mgf(): Numerically estimates the moment-generating function.

Usage:
CoreStatistics$mgf(t, ...)

Arguments:

t (integer(1))
  t integer to evaluate function at.

... ANY
  Passed to $genExp.
Method cf(): Numerically estimates the characteristic function.
Usage:
CoreStatistics$cf(t, ...)
Arguments:
t (integer(1))
   t integer to evaluate function at.
... ANY
   Passed to $genExp.

Method pgf(): Numerically estimates the probability-generating function.
Usage:
CoreStatistics$pgf(z, ...)
Arguments:
z (integer(1))
   z integer to evaluate probability generating function at.
... ANY
   Passed to $genExp.

Method entropy(): Numerically estimates the entropy function.
Usage:
CoreStatistics$entropy(base = 2, ...)
Arguments:
base (integer(1))
   Base of the entropy logarithm, default = 2 (Shannon entropy)
... ANY
   Passed to $genExp.

Method skewness(): Numerically estimates the distribution skewness.
Usage:
CoreStatistics$skewness(...)
Arguments:
... ANY
   Passed to $genExp.

Method kurtosis(): Numerically estimates the distribution kurtosis.
Usage:
CoreStatistics$kurtosis(excess = TRUE, ...)
Arguments:
excess (logical(1))
   If TRUE (default) excess kurtosis returned.
... ANY
   Passed to $genExp.

Method variance(): Numerically estimates the distribution variance.
Usage:
CoreStatistics$variance(...)

Arguments:
... ANY
   Passed to $genExp.

Method \texttt{kthmoment()}: The kth central moment of a distribution is defined by
\[ CM(k)_X = E_X[(x - \mu)^k] \]
the kth standardised moment of a distribution is defined by
\[ SM(k)_X = \frac{CM(k)}{\sigma^k} \]
the kth raw moment of a distribution is defined by
\[ RM(k)_X = E_X[x^k] \]
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
CoreStatistics$kthmoment(k, type = c("central", "standard", "raw"), ...) 

Arguments:
\( k \) integer(1)
   The k-th moment to evaluate the distribution at.
\( type \) character(1)
   Type of moment to evaluate.
... ANY
   Passed to $genExp.

Method \texttt{genExp()}: Numerically estimates \( E[f(X)] \) for some function \( f \).

Usage:
CoreStatistics$genExp(trafo = NULL, cubature = FALSE, ...) 

Arguments:
\( \texttt{trafo} \) function()
   Transformation function to define the expectation, default is distribution mean.
\( \texttt{cubature} \) logical(1)
   If TRUE uses \texttt{cubature::cubintegrate} for approximation, otherwise \texttt{integrate}.
... ANY
   Passed to \texttt{cubature::cubintegrate}.

Method \texttt{mode()}: Numerically estimates the distribution mode.

Usage:
CoreStatistics$mode(which = "all") 

Arguments:
which (character(1) | numeric(1))
Ignored if distribution is unimodal. Otherwise “all” returns all modes, otherwise specifies
which mode to return.

Method mean(): Numerically estimates the distribution mean.
Usage:
CoreStatistics$mean(...)
Arguments:
... ANY
Passed to $genExp.

Method clone(): The objects of this class are cloneable with this method.
Usage:
CoreStatistics$clone(deep = FALSE)
Arguments:
deep Whether to make a deep clone.

See Also
Other decorators: ExoticStatistics, FunctionImputation

Examples

decorate(Exponential$new(), "CoreStatistics")
Exponential$new(decorators = "CoreStatistics")
CoreStatistics$new()$decorate(Exponential$new())

---

correlation Distribution Correlation

Description
Correlation of a distribution.

Usage
correlation(object)

Arguments
object Distribution.

Value
Either '1' if distribution is univariate or the correlation as a numeric or matrix.
Description

Mathematical and statistical functions for the Cosine kernel defined by the pdf,
\[ f(x) = \frac{\pi}{4}\cos\left(x\frac{\pi}{2}\right) \]
over the support \( x \in (-1, 1) \).

Super classes

distr6::Distribution -> distr6::Kernel -> Cosine

Public fields

- name: Full name of distribution.
- short_name: Short name of distribution for printing.
- description: Brief description of the distribution.

Methods

Public methods:
- Cosine$pdfSquared2Norm()
- Cosine$cdfSquared2Norm()
- Cosine$variance()
- Cosine$clone()

Method pdfSquared2Norm(): The squared 2-norm of the pdf is defined by
\[ \int_{a}^{b} (f_X(u))^2 \, du \]
where \( X \) is the Distribution, \( f_X \) is its pdf and \( a, b \) are the distribution support limits.
Usage:
Cosine$pdfSquared2Norm(x = 0, upper = Inf)
Arguments:
- x (numeric(1))
  Amount to shift the result.
- upper (numeric(1))
  Upper limit of the integral.

Method cdfSquared2Norm(): The squared 2-norm of the cdf is defined by
\[ \int_{a}^{b} (F_X(u))^2 \, du \]
where \( X \) is the Distribution, \( F_X \) is its pdf and \( a, b \) are the distribution support limits.
Usage:
Cosine$cdfSquared2Norm(x = 0, upper = 0)

Arguments:
  x (numeric(1))
    Amount to shift the result.
  upper (numeric(1))
    Upper limit of the integral.

Method variance(): The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
Cosine$variance(...) 

Arguments:
  ... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Cosine$clone(deep = FALSE) 

Arguments:
  deep Whether to make a deep clone.

See Also

Other kernels: Epanechnikov, LogisticKernel, NormalKernel, Quartic, Sigmoid, Silverman, TriangularKernel, Tricube, Triweight, UniformKernel

---

**cum Hazard**

Cumulative Hazard Function

Description

See ExoticStatistics$cumHazard.

Usage

cumHazard(object, ..., log = FALSE, simplify = TRUE, data = NULL)
Decorate Distributions

Functionality to decorate R6 Distributions (and child classes) with extra methods.

Usage

decorate(distribution, decorators, ...)

Arguments

distribution ([Distribution])
Distribution to decorate.

decorators (character()) Vector of DistributionDecorator names to decorate the Distribution with.

... ANY
Extra arguments passed down to specific decorators.
Decorators

Decorating is the process of adding methods to classes that are not part of the core interface (Gamma et al. 1994). Use `listDecorators` to see which decorators are currently available. The primary use-cases are to add numeric results when analytic ones are missing, to add complex modelling functions and to impute missing d/p/q/r functions.

Value

Returns a `Distribution` with additional methods from the chosen `DistributionDecorator`.

References

Gamma, Erich, Richard Helm, Ralph Johnson, and John Vlissides. 1994. “Design Patterns: Elements of Reusable Object-Oriented Software.” Addison-Wesley.

See Also

`listDecorators()` for available decorators and `DistributionDecorator` for the parent class.

Examples

```r
B <- Binomial$new()
decorate(B, "CoreStatistics")

E <- Exponential$new()
decorate(E, c("CoreStatistics", "ExoticStatistics"))
```

---

<table>
<thead>
<tr>
<th>decorators</th>
<th>Decorators Accessor</th>
</tr>
</thead>
</table>

Description

Returns the decorators added to a distribution.

Usage

`decorators(object)`

Arguments

- `object` Distribution.

Value

Character vector of decorators.

R6 Usage

`$decorators`
Degenerate

**Degenerate Distribution Class**

**Description**

Mathematical and statistical functions for the Degenerate distribution, which is commonly used to model deterministic events or as a representation of the delta, or Heaviside, function.

**Details**

The Degenerate distribution parameterised with mean, $\mu$ is defined by the pmf,

\[
    f(x) = \begin{cases} 
    1, & \text{if } x = \mu \\
    0, & \text{if } x \neq \mu 
    \end{cases}
\]

for $\mu \in \mathbb{R}$.

**Value**

Returns an R6 object inheriting from class SDistribution.

**Distribution support**

The distribution is supported on $\mu$.

**Default Parameterisation**

Degen(mean = 0)

**Omitted Methods**

N/A

**Also known as**

Also known as the Dirac distribution.

**Super classes**

```
  distr6::Distribution -> distr6::SDistribution -> Degenerate
```

**Public fields**

- name: Full name of distribution.
- short_name: Short name of distribution for printing.
- description: Brief description of the distribution.
Methods

Public methods:

• `Degenerate$new()`  
• `Degenerate$mean()`  
• `Degenerate$mode()`  
• `Degenerate$variance()`  
• `Degenerate$skewness()`  
• `Degenerate$kurtosis()`  
• `Degenerate$entropy()`  
• `Degenerate$mgf()`  
• `Degenerate$cf()`  
• `Degenerate$setParameterValue()`  
• `Degenerate$clone()`

Method `new()`: Creates a new instance of this R6 class.

Usage:
`Degenerate$new(mean = NULL, decorators = NULL)`

Arguments:

mean numeric(1)  
Mean of the distribution, defined on the Reals.
decorators (character())  
Decorators to add to the distribution during construction.

Method `mean()`: The arithmetic mean of a (discrete) probability distribution \( X \) is the expectation

\[
E_X(X) = \sum p_X(x) \times x
\]

with an integration analogue for continuous distributions.

Usage:
`Degenerate$mean(...)`

Arguments:

... Unused.

Method `mode()`: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
`Degenerate$mode(which = "all")`

Arguments:

which (character(1) | numeric(1))  
Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.
Method \texttt{variance()}: The variance of a distribution is defined by the formula
\[ \text{var}_X = E[X^2] - E[X]^2 \]
where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

\textit{Usage:}
\texttt{Degenerate$\text{variance}(...) \allowbreak}

\textit{Arguments:}
... Unused.

Method \texttt{skewness()}: The skewness of a distribution is defined by the third standardised moment,
\[ \text{sk}_X = E_X \left[ \frac{x - \mu^3}{\sigma} \right] \]
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

\textit{Usage:}
\texttt{Degenerate$\text{skewness}(...) \allowbreak}

\textit{Arguments:}
... Unused.

Method \texttt{kurtosis()}: The kurtosis of a distribution is defined by the fourth standardised moment,
\[ k_X = E_X \left[ \frac{x - \mu^4}{\sigma} \right] \]
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

\textit{Usage:}
\texttt{Degenerate$\text{kurtosis}(\text{excess} = \text{TRUE}, \ldots) \allowbreak}

\textit{Arguments:}
\texttt{excess (logical(1))}
  - If \texttt{TRUE} (default) excess kurtosis returned.
... Unused.

Method \texttt{entropy()}: The entropy of a (discrete) distribution is defined by
\[ -\sum (f_X) \log(f_X) \]
where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

\textit{Usage:}
\texttt{Degenerate$\text{entropy}(\text{base} = \text{2}, \ldots) \allowbreak}

\textit{Arguments:}
\texttt{base (integer(1))}
  - Base of the entropy logarithm, default = 2 (Shannon entropy)
Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X[exp(xt)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X.

Usage:
Degenerate$mgf(t, ...)

Arguments:
t (integer(1))
   t integer to evaluate function at.
... Unused.

Method cf(): The characteristic function is defined by

\[ cf_X(t) = E_X[exp(xti)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X.

Usage:
Degenerate$cf(t, ...)

Arguments:
t (integer(1))
   t integer to evaluate function at.
... Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
Degenerate$setParameterValue(
   ..., 
   lst = NULL,
   error = "warn",
   resolveConflicts = FALSE
)

Arguments:
... ANY
   Named arguments of parameters to set values for. See examples.
lst (list(1))
   Alternative argument for passing parameters. List names should be parameter names and
   list values are the new values to set.
error (character(1))
   If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
   If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
   tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.
Dirichlet Distribution Class

Description

Mathematical and statistical functions for the Dirichlet distribution, which is commonly used as a prior in Bayesian modelling and is multivariate generalisation of the Beta distribution.

Details

The Dirichlet distribution parameterised with concentration parameters, \( \alpha_1, ..., \alpha_k \), is defined by the pdf,

\[
f(x_1, ..., x_k) = \frac{1}{\Gamma(\sum \alpha_i)} \prod \Gamma(\alpha_i) \prod x_i^{\alpha_i - 1}
\]

for \( \alpha = \alpha_1, ..., \alpha_k; \alpha > 0 \), where \( \Gamma \) is the gamma function.

Sampling is performed via sampling independent Gamma distributions and normalising the samples (Devroye, 1986).

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on \( x_i \in (0, 1), \sum x_i = 1 \).
Default Parameterisation

Diri(params = c(1, 1))

Omitted Methods

cdf and quantile are omitted as no closed form analytic expression could be found, decorate with `FunctionImputation` for a numerical imputation.

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> Dirichlet

Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.
packages  Packages required to be installed in order to construct the distribution.

Methods

Public methods:

- Dirichlet$new()
- Dirichlet$mean()
- Dirichlet$mode()
- Dirichlet$variance()
- Dirichlet$entropy()
- Dirichlet$pgf()
- Dirichlet$setParameterValue()
- Dirichlet$clone()

Method new(): Creates a new instance of this R6 class.

Usage:

Dirichlet$new(params = NULL, decorators = NULL)

Arguments:

params numeric()
  Vector of concentration parameters of the distribution defined on the positive Reals.
decorators (character())
  Decorators to add to the distribution during construction.
**Method mean()**: The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

$$E_X(X) = \sum p_X(x) \ast x$$

with an integration analogue for continuous distributions.

**Usage**:

`Dirichlet$mean(...)`

**Arguments**:

... Unused.

**Method mode()**: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

**Usage**:

`Dirichlet$mode(which = "all")`

**Arguments**:

which (character(1) | numeric(1))

Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

**Method variance()**: The variance of a distribution is defined by the formula

$$var_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution $X$. If the distribution is multivariate the covariance matrix is returned.

**Usage**:

`Dirichlet$variance(...)`

**Arguments**:

... Unused.

**Method entropy()**: The entropy of a (discrete) distribution is defined by

$$-\sum (f_X)log(f_X)$$

where $f_X$ is the pdf of distribution $X$, with an integration analogue for continuous distributions.

**Usage**:

`Dirichlet$entropy(base = 2, ...)`

**Arguments**:

base (integer(1))

Base of the entropy logarithm, default = 2 (Shannon entropy)

... Unused.

**Method pgf()**: The probability generating function is defined by

$$pgf_X(z) = E_X[exp(z^x)]$$

where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$. 
Usage:
Dirichlet$pgf(z, ...)

Arguments:
z (integer(1))
    z integer to evaluate probability generating function at.
... Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
Dirichlet$setParameterValue(
    ..., 
    lst = NULL,
    error = "warn",
    resolveConflicts = FALSE
)

Arguments:
... ANY
    Named arguments of parameters to set values for. See examples.
lst (list(1))
    Alternative argument for passing parameters. List names should be parameter names and
    list values are the new values to set.
error (character(1))
    If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
    If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
    tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Dirichlet$clone(deep = FALSE)
Arguments:
deep Whether to make a deep clone.

References
Michael P. McLaughlin.
96305-7.

See Also
Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral,
ChiSquared, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma,
Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal,
Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT,
Triangular, Uniform, Wald, Weibull
Other multivariate distributions: EmpiricalMV, Multinomial, MultivariateNormal
Examples

```r
  d <- Dirichlet$new(params = c(2, 5, 6))
  d$pdf(0.1, 0.4, 0.5)
  d$pdf(c(0.3, 0.2), c(0.6, 0.9), c(0.9, 0.1))
```

---

**DiscreteUniform**

*Discrete Uniform Distribution Class*

**Description**

Mathematical and statistical functions for the Discrete Uniform distribution, which is commonly used as a discrete variant of the more popular Uniform distribution, used to model events with an equal probability of occurring (e.g. role of a die).

**Details**

The Discrete Uniform distribution parameterised with lower, $a$, and upper, $b$, limits is defined by the pmf,

$$ f(x) = \frac{1}{b - a + 1} $$

for $a, b \in \mathbb{Z}; b \geq a$.

**Value**

Returns an R6 object inheriting from class `SDistribution`.

**Distribution support**

The distribution is supported on \{a, a+1, ..., b\}.

**Default Parameterisation**

DUnif(lower = 0, upper = 1)

**Omitted Methods**

N/A

**Also known as**

N/A

**Super classes**

`distr6::Distribution` -> `distr6::SDistribution` -> `DiscreteUniform`
Public fields

- **name**  Full name of distribution.
- **short_name**  Short name of distribution for printing.
- **description**  Brief description of the distribution.
- **packages**  Packages required to be installed in order to construct the distribution.

Methods

**Public methods:**

- `DiscreteUniform$new()`
- `DiscreteUniform$mean()`
- `DiscreteUniform$mode()`
- `DiscreteUniform$variance()`
- `DiscreteUniform$skewness()`
- `DiscreteUniform$kurtosis()`
- `DiscreteUniform$entropy()`
- `DiscreteUniform$mgf()`
- `DiscreteUniform$cf()`
- `DiscreteUniform$pgf()`
- `DiscreteUniform$setParameterValue()`
- `DiscreteUniform$clone()`

**Method new():** Creates a new instance of this R6 class.

*Usage:*

```
DiscreteUniform$new(lower = NULL, upper = NULL, decorators = NULL)
```

*Arguments:*

- **lower**  (integer(1))
  Lower limit of the Distribution, defined on the Naturals.
- **upper**  (integer(1))
  Upper limit of the Distribution, defined on the Naturals.
- **decorators**  (character())
  Decorators to add to the distribution during construction.

**Method mean():** The arithmetic mean of a (discrete) probability distribution \( X \) is the expectation

\[
E_X(X) = \sum p_X(x) \ast x
\]

with an integration analogue for continuous distributions.

*Usage:*

```
DiscreteUniform$mean(...)
```

*Arguments:*

- **...**  Unused.
Method `mode()`: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
```
DiscreteUniform$mode(which = "all")
```

Arguments:
- `which` (character(1) | numeric(1))
  - Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method `variance()`: The variance of a distribution is defined by the formula

\[
\text{var}_X = E[X^2] - E[X]^2
\]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
```
DiscreteUniform$variance(...)  # Unused.
```

Method `skewness()`: The skewness of a distribution is defined by the third standardised moment,

\[
\text{sk}_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3
\]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
```
DiscreteUniform$skewness(...)  # Unused.
```

Method `kurtosis()`: The kurtosis of a distribution is defined by the fourth standardised moment,

\[
\text{k}_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4
\]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
```
DiscreteUniform$kurtosis(excess = TRUE, ...)  # If TRUE (default) excess kurtosis returned.
```

Arguments:
- `excess` (logical(1))
  - If TRUE (default) excess kurtosis returned.
  - ... Unused.
Method entropy(): The entropy of a (discrete) distribution is defined by

\[-\sum (f_X) \log(f_X)\]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
DiscreteUniform$entropy(base = 2, ...)

Arguments:
base (integer(1))
  Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E\{\exp(\cdot t)\} \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
DiscreteUniform$mgf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Unused.

Method cf(): The characteristic function is defined by

\[ cf_X(t) = E\{\exp(\cdot ti)\} \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
DiscreteUniform(cf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Unused.

Method pgf(): The probability generating function is defined by

\[ pgf_X(z) = E\{\exp(\cdot z)\} \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
DiscreteUniform$pgf(z, ...)

Arguments:
z (integer(1))
  z integer to evaluate probability generating function at.
... Unused.

**Method** `setParameterValue()`: Sets the value(s) of the given parameter(s).

*Usage:*
DiscreteUniform$setParameterValue(
    ...,
    lst = NULL,
    error = "warn",
    resolveConflicts = FALSE
)

*Arguments:*

... ANY
    Named arguments of parameters to set values for. See examples.

lst (list(1))
    Alternative argument for passing parameters. List names should be parameter names and
    list values are the new values to set.

error (character(1))
    If "warn" then returns a warning on error, otherwise breaks if "stop".

resolveConflicts (logical(1))
    If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
    tomatically resolves them by removing all conflicting parameters.

**Method** `clone()`: The objects of this class are cloneable with this method.

*Usage:*
DiscreteUniform$clone(deep = FALSE)

*Arguments:*

deep Whether to make a deep clone.

**References**

Michael P. McLaughlin.

**See Also**

Other discrete distributions: Bernoulli, Binomial, Categorical, Degenerate, EmpiricalMV,
Empirical, Geometric, Hypergeometric, Logarithmic, Multinomial, NegativeBinomial, WeightedDiscrete

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical,
Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, Empirical, Erlang, Exponential,
FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel,
Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal,
NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral,
StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete
distr6News

Show distr6 NEWS.md File

Description
Displays the contents of the NEWS.md file for viewing distr6 release information.

Usage
distr6News()

Value
NEWS.md in viewer.

Examples
## Not run:
distr6News()

## End(Not run)

Distribution

Generalised Distribution Object

Description
A generalised distribution object for defining custom probability distributions as well as serving as the parent class to specific, familiar distributions.

Value
Returns R6 object of class Distribution.

Public fields

- name Full name of distribution.
- short_name Short name of distribution for printing.
- description Brief description of the distribution.
Active bindings

- decorators Returns decorators currently used to decorate the distribution.
- traits Returns distribution traits.
- valueSupport Deprecated, use $traits$valueSupport.
- variateForm Deprecated, use $traits$variateForm.
- type Deprecated, use $traits$type.
- properties Returns distribution properties, including skewness type and symmetry.
- support Deprecated, use $properties$type.
- symmetry Deprecated, use $properties$symmetry.
- sup Returns supremum (upper bound) of the distribution support.
- inf Returns infimum (lower bound) of the distribution support.
- dmax Returns maximum of the distribution support.
- dmin Returns minimum of the distribution support.
- kurtosisType Deprecated, use $properties$kurtosis.
- skewnessType Deprecated, use $properties$skewness.

Methods

**Public methods:**

- `Distribution$new()`
- `Distribution$strprint()`
- `Distribution$print()`
- `Distribution$summary()`
- `Distribution$parameters()`
- `Distribution$get_ParameterValue()`
- `Distribution$set_ParameterValue()`
- `Distribution$pdf()`
- `Distribution$cdf()`
- `Distribution$quantile()`
- `Distribution$rand()`
- `Distributionpreci()`
- `Distribution$stdev()`
- `Distribution$median()`
- `Distribution$sqr()`
- `Distribution$correlation()`
- `Distribution$liesInSupport()`
- `Distribution$liesInType()`
- `Distribution$workingSupport()`
- `Distribution$clone()`

**Method `new()`**: Creates a new instance of this R6 class.
Usage:
```
Distribution$new(
  name = NULL,
  short_name = NULL,
  type,
  support = NULL,
  symmetric = FALSE,
  pdf = NULL,
  cdf = NULL,
  quantile = NULL,
  rand = NULL,
  parameters = NULL,
  decorators = NULL,
  valueSupport = NULL,
  variateForm = NULL,
  description = NULL,
  .suppressChecks = FALSE
)
```

Arguments:

name character(1)
  Full name of distribution.
short_name character(1)
  Short name of distribution for printing.
type (set6::Set)
  Distribution type.
support (set6::Set)
  Distribution support.
symmetric logical(1)
  Symmetry type of the distribution.
pdf function
  Probability density function of the distribution. At least one of pdf and cdf must be provided.
cdf function
  Cumulative distribution function of the distribution. At least one of pdf and cdf must be provided.
quantile function
  Quantile (inverse-cdf) function of the distribution.
r and function
  Simulation function for drawing random samples from the distribution.
parameters (ParameterSet)
  Parameter set for defining the parameters in the distribution, which should be set before construction.
decorators (character())
  Decorators to add to the distribution during construction.
valueSupport (character(1))
  The support type of the distribution, one of "discrete", "continuous", "mixture". If NULL, determined automatically.
vartateForm (character(1))
  The vartate type of the distribution, one of "univariate", "multivariate", "matrixvartate". If
  NULL, determined automatically.
description (character(1))
  Optional short description of the distribution.
.suppressChecks (logical(1))
  Used internally.

**Method strprint():** Printable string representation of the Distribution. Primarily used internally.

  **Usage:**
  Distribution$strprint(n = 2)

  **Arguments:**
  n (integer(1))
    Number of parameters to display when printing.

**Method print():** Prints the Distribution.

  **Usage:**
  Distribution$print(n = 2, ...)

  **Arguments:**
  n (integer(1))
    Passed to $strprint.
  ... ANY
    Unused. Added for consistency.

**Method summary():** Prints a summary of the Distribution.

  **Usage:**
  Distribution$summary(full = TRUE, ...)

  **Arguments:**
  full (logical(1))
    If TRUE (default) prints a long summary of the distribution, otherwise prints a shorter sum-
    mary.
  ... ANY
    Unused. Added for consistency.

**Method parameters():** Returns the full parameter details for the supplied parameter.

  **Usage:**
  Distribution$parameters(id = NULL)

  **Arguments:**
  id character()
    id of parameter value to return.

**Method getParameterValue():** Returns the value of the supplied parameter.

  **Usage:**
Distribution$getParameterValue(id, error = "warn")

Arguments:
id character()
  id of parameter value to return.
error (character(1))
  If "warn" then returns a warning on error, otherwise breaks if "stop".

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
Distribution$setParameterValue(
  ..., 
  lst = NULL,
  error = "warn",
  resolveConflicts = FALSE
)

Arguments:
... ANY
  Named arguments of parameters to set values for. See examples.
lst (list(1))
  Alternative argument for passing parameters. List names should be parameter names and
  list values are the new values to set.
error (character(1))
  If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
  If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
  tomatically resolves them by removing all conflicting parameters.

Examples:
b = Binomial$new()
b$setParameterValue(size = 4, prob = 0.4)
b$setParameterValue(lst = list(size = 4, prob = 0.4))

Method pdf(): For discrete distributions the probability mass function (pmf) is returned, defined as

\[ p_X(x) = P(X = x) \]

for continuous distributions the probability density function (pdf), \( f_X \), is returned

\[ f_X(x) = P(x < X \leq x + dx) \]

for some infinitesimally small \( dx \).

If available a pdf will be returned using an analytic expression. Otherwise, if the distribution has not been decorated with FunctionImputation, NULL is returned.

Usage:
Distribution$pdf(..., log = FALSE, simplify = TRUE, data = NULL)

Arguments:
Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

log (logical(1))
  If TRUE returns the logarithm of the probabilities. Default is FALSE.
simplify logical(1)
  If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.
data array
  Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

Examples:

```r
b <- Binomial$new()
b$pdf(1:10)
b$pdf(1:10, log = TRUE)
b$pdf(data = matrix(1:10))

mvn <- MultivariateNormal$new()
mvn$pdf(1, 2)
mvn$pdf(1:2, 3:4)
mvn$pdf(data = matrix(1:4, nrow = 2), simplify = FALSE)
```

Method cdf(): The (lower tail) cumulative distribution function, \( F_X \), is defined as

\[
F_X(x) = P(X \leq x)
\]

If lower.tail is FALSE then \( 1 - F_X(x) \) is returned, also known as the survival function.

If available a cdf will be returned using an analytic expression. Otherwise, if the distribution has not been decorated with FunctionImputation, NULL is returned.

Usage:

```r
Distribution$cdf(
  ..., 
  lower.tail = TRUE, 
  log.p = FALSE,  
  simplify = TRUE,  
  data = NULL
)
```

Arguments:

... (numeric())
  Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

lower.tail (logical(1))
  If TRUE (default), probabilities are \( X \leq x \), otherwise, \( P(X > x) \).
log.p (logical(1))
    If TRUE returns the logarithm of the probabilities. Default is FALSE.
simplify logical(1)
    If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.
data array
    Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

Examples:
b <- Binomial$new()
b$cdf(1:10)
b$cdf(1:10, log.p = TRUE, lower.tail = FALSE)
b$cdf(data = matrix(1:10))

Method quantile(): The quantile function, $q_X$, is the inverse cdf, i.e.

$$q_X(p) = F_X^{-1}(p) = \inf\{x \in R : F_X(x) \geq p\}$$

#nolint
If lower.tail is FALSE then $q_X(1 - p)$ is returned.
If available a quantile will be returned using an analytic expression. Otherwise, if the distribution has not been decorated with FunctionImputation, NULL is returned.

Usage:
Distribution$quantile(
    ..., 
    lower.tail = TRUE, 
    log.p = FALSE, 
    simplify = TRUE, 
    data = NULL 
)

Arguments:
... (numeric())
    Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.
lower.tail (logical(1))
    If TRUE (default), probabilities are $X \leq x$, otherwise, $P(X > x)$.
log.p (logical(1))
    If TRUE returns the logarithm of the probabilities. Default is FALSE.
simplify logical(1)
    If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.
data array
    Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.
Examples:
b <- Binomial$new()
b$quantile(0.42)
b$quantile(log(0.42), log.p = TRUE, lower.tail = TRUE)
b$quantile(data = matrix(c(0.1,0.2)))

**Method** `rand()`: The rand function draws n simulations from the distribution. If available simulations will be returned using an analytic expression. Otherwise, if the distribution has not been decorated with `FunctionImputation`, NULL is returned.

**Usage:**
Distribution$rand(n, simplify = TRUE)

**Arguments:**
n (numeric(1))
  Number of points to simulate from the distribution. If length greater than 1, then n <- length(n),
simplify logical(1)
  If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.

Examples:
b <- Binomial$new()
b$rand(10)

mvn <- MultivariateNormal$new()
mvn$rand(5)

**Method** `prec()`: Returns the precision of the distribution as 1/self$variance().

**Usage:**
Distribution$prec()

**Method** `stdev()`: Returns the standard deviation of the distribution as sqrt(self$variance()).

**Usage:**
Distribution$stdev()

**Method** `median()`: Returns the median of the distribution. If an analytical expression is available returns distribution median, otherwise if symmetric returns self$mean, otherwise returns self$quantile(0.5).

**Usage:**
Distribution$median(na.rm = NULL, ...)

**Arguments:**
na.rm (logical(1))
  Ignored, added for consistency.
... ANY
  Ignored, added for consistency.

**Method** `iqr()`: Inter-quartile range of the distribution. Estimated as self$quantile(0.75) - self$quantile(0.25).

**Usage:**
Distribution$iqr() Method correlation(): If univariate returns 1, otherwise returns the distribution correlation.

Usage:
Distribution$correlation()

Method liesInSupport(): Tests if the given values lie in the support of the distribution. Uses [set6::Set]$contains.

Usage:
Distribution$liesInSupport(x, all = TRUE, bound = FALSE)

Arguments:
x ANY Values to test.
all logical(1) If TRUE (default) returns TRUE if all x are in the distribution, otherwise returns a vector of logicals corresponding to each element in x.
bound logical(1) If TRUE then tests if x lie between the upper and lower bounds of the distribution, otherwise tests if x lie between the maximum and minimum of the distribution.

Method liesInType(): Tests if the given values lie in the type of the distribution. Uses [set6::Set]$contains.

Usage:
Distribution$liesInType(x, all = TRUE, bound = FALSE)

Arguments:
x ANY Values to test.
all logical(1) If TRUE (default) returns TRUE if all x are in the distribution, otherwise returns a vector of logicals corresponding to each element in x.
bound logical(1) If TRUE then tests if x lie between the upper and lower bounds of the distribution, otherwise tests if x lie between the maximum and minimum of the distribution.

Method workingSupport(): Returns an estimate for the computational support of the distribution. If an analytical cdf is available, then this is computed as the smallest interval in which the cdf lower bound is 0 and the upper bound is 1, bounds areincremented in $10^\chi$ intervals. If no analytical cdf is available, then this is computed as the smallest interval in which the lower and upper bounds of the pdf are 0, this is much less precise and is more prone to error. Used primarily by decorators.

Usage:
Distribution$workingSupport()

Method clone(): The objects of this class are cloneable with this method.

Usage:
Distribution$clone(deep = FALSE)

Arguments:
depth Whether to make a deep clone.
Examples

```r
## Method `Distribution$setParameterValue`
## ------------------------------------------------

b = Binomial$new()
b$setParameterValue(size = 4, prob = 0.4)
b$setParameterValue(lst = list(size = 4, prob = 0.4))

## Method `Distribution$pdf`
## ------------------------------------------------

b <- Binomial$new()
b$pdf(1:10)
b$pdf(1:10, log = TRUE)
b$pdf(data = matrix(1:10))

mvn <- MultivariateNormal$new()
mvn$pdf(1, 2)
mvn$pdf(1:2, 3:4)
mvn$pdf(data = matrix(1:4, nrow = 2), simplify = FALSE)

## Method `Distribution$cdf`
## ------------------------------------------------

b <- Binomial$new()
b$cdf(1:10)
b$cdf(1:10, log.p = TRUE, lower.tail = FALSE)
b$cdf(data = matrix(1:10))

## Method `Distribution$quantile`
## ------------------------------------------------

b <- Binomial$new()
b$quantile(0.42)
b$quantile(log(0.42), log.p = TRUE, lower.tail = TRUE)
b$quantile(data = matrix(c(0.1,0.2)))

## Method `Distribution$rand`
## ------------------------------------------------

b <- Binomial$new()
b$rand(10)

mvn <- MultivariateNormal$new()
mvn$rand(5)
```
DistributionDecorator  

Abstract DistributionDecorator Class

Description

Abstract class that cannot be constructed directly.

Details

Decorating is the process of adding methods to classes that are not part of the core interface (Gamma et al. 1994). Use listDecorators to see which decorators are currently available. The primary use-cases are to add numeric results when analytic ones are missing, to add complex modelling functions and to impute missing d/p/q/r functions.

Use decorate or $decorate to decorate distributions.

Value

Returns error. Abstract classes cannot be constructed directly.

An R6 object.

Public fields

packages  Packages required to be installed in order to construct the distribution.

Active bindings

methods  Returns the names of the available methods in this decorator.

Methods

Public methods:

- DistributionDecorator$new()
- DistributionDecorator$decorate()
- DistributionDecorator$clone()

Method new(): Creates a new instance of this R6 class.

Usage:

DistributionDecorator$new()

Method decorate(): Decorates the given distribution with the methods available in this decorator.

Usage:

DistributionDecorator$decorate(distribution, ...)

Arguments:

distribution  Distribution

  Distribution to decorate.
Method clone(): The objects of this class are cloneable with this method.

Usage:
DistributionDecorator$clone(deep = FALSE)

Arguments:
depth Whether to make a deep clone.

References
Gamma, Erich, Richard Helm, Ralph Johnson, and John Vlissides. 1994. “Design Patterns: Elements of Reusable Object-Oriented Software.” Addison-Wesley.
DistributionWrapper$new(
  distlist = NULL,
  name,
  short_name,
  description,
  support,
  type,
  valueSupport,
  variateForm,
  parameters = NULL,
  outerID = NULL
)

Arguments:

distlist (list())
  List of Distributions.
name (character(1))
  Wrapped distribution name.
short_name (character(1))
  Wrapped distribution ID.
description (character())
  Wrapped distribution description.
support ([set6::Set])
  Wrapped distribution support.
type ([set6::Set])
  Wrapped distribution type.
valueSupport (character(1))
  Wrapped distribution value support.
variateForm (character(1))
  Wrapped distribution variate form.
parameters ([ParameterSetCollection])
  Optional parameters to add to the internal collection, ignored if distlist is given.
outerID ([ParameterSet])
  Parameters added by the wrapper.

Method wrappedModels(): Returns model(s) wrapped by this wrapper.

Usage:
DistributionWrapper$wrappedModels(model = NULL)

Arguments:

model (character(1))
  id of wrapped Distributions to return. If NULL (default), a list of all wrapped Distributions is returned; if only one Distribution is matched then this is returned, otherwise a list of Distributions.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
distrSimulate

DistributionWrapper$setParameterValue(
  ..., 
  lst = NULL,
  error = "warn",
  resolveConflicts = FALSE
)

Arguments:
... ANY
  Named arguments of parameters to set values for. See examples.
lst (list(1))
  Alternative argument for passing parameters. List names should be parameter names and
  list values are the new values to set.
error (character(1))
  If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
  If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
  tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
DistributionWrapper$clone(deep = FALSE)

Arguments:
  deep Whether to make a deep clone.

References
Gamma, Erich, Richard Helm, Ralph Johnson, and John Vlissides. 1994. “Design Patterns: Ele-
ments of Reusable Object-Oriented Software.” Addison-Wesley.

See Also
Other wrappers: Convolution, HuberizedDistribution, MixtureDistribution, ProductDistribution,
TruncatedDistribution, VectorDistribution

---

distrSimulate Simulate from a Distribution

Description
Helper function to quickly simulate from a distribution with given parameters.
Usage

```r
distrSimulate(
  n = 100,
  distribution = "Normal",
  pars = list(),
  simplify = TRUE,
  seed,
  ...
)
```

Arguments

- `n` : number of points to simulate.
- `distribution` : distribution to simulate from, corresponds to `ClassName` of `distr6` distribution, abbreviations allowed.
- `pars` : parameters to pass to `distribution`. If omitted then `distribution` defaults used.
- `simplify` : if `TRUE` (default) only the simulations are returned, otherwise the constructed distribution is also returned.
- `seed` : passed to `set.seed`
- `...` : additional optional arguments for `set.seed`

Value

If `simplify` then vector of `n` simulations, otherwise list of simulations and distribution.

See Also

- `rand`

---

**dmax**

*Distribution Maximum Accessor*

Description

Returns the distribution maximum as the maximum of the support. If the support is not bounded above then maximum is given by

\[ maximum = \text{supremum} - 1.1e - 15 \]

Usage

```r
dmax(object)
```

Arguments

- `object` : Distribution.
\textit{dmin}  

\textbf{Value}  

Maximum as a numeric.  

\textbf{R6 Usage}  

\texttt{sdmax}  

\textbf{See Also}  

\texttt{support.dmin.sup.inf}  

---  

\textbf{dmin} \hspace{1cm} \textit{Distribution Minimum Accessor}  

\textbf{Description}  

Returns the distribution minimum as the minimum of the support. If the support is not bounded below then minimum is given by  

\[ \text{minimum} = \text{infimum} + 1.1e - 15 \]

\textbf{Usage}  

\texttt{dmin(object)}  

\textbf{Arguments}  

\begin{itemize}  
  \item \texttt{object} \hspace{1cm} \text{Distribution.}  
\end{itemize}  

\textbf{Value}  

Minimum as a numeric.  

\textbf{R6 Usage}  

\texttt{sdmin}
dstr

Helper Functionality for Constructing Distributions

Description
Helper functions for constructing an SDistribution (with dstr) or VectorDistribution (with dstrs).

Usage

dstr(d, ..., pars = NULL)
dstrs(d, pars = NULL, ...)

Arguments
d (character(1))
Distribution. Can be the ShortName or ClassName from listDistributions().

... (ANY)
Passed to the distribution constructor, should be parameters or decorators.

pars (list())
List of parameters of same length as d corresponding to distribution parameters.

Examples

# Construct standard Normal and distribution
dstr("Norm") # ShortName
dstr("Normal") # ClassName

# Construct Binomial(5, 0.1)
dstr("Binomial", size = 5, prob = 0.1)

# Construct decorated Gamma(2, 1)
dstr("Gamma", shape = 2, rate = 1,
   decorators = "ExoticStatistics")

# Or with a list
dstr("Gamma", pars = list(shape = 2, rate = 4))

# Construct vector with dstrs

# Binomial and Gamma with default parameters
dstrs(c("Binom", "Gamma"))

# Binomial with set parameters and Gamma with
# default parameters
dstrs(c("Binom", "Gamma"), list(list(size = 4), NULL))

# Binomial and Gamma with set parameters
dstrs(c("Binom", "Gamma"),
Empirical Distribution Class

**Description**

Mathematical and statistical functions for the Empirical distribution, which is commonly used in sampling such as MCMC.

**Details**

The Empirical distribution is defined by the pmf,

\[ p(x) = \sum I(x = x_i)/k \]

for \( x_i \in \mathbb{R}, i = 1, ..., k \).

Sampling from this distribution is performed with the `sample` function with the elements given as the support set and uniform probabilities. Sampling is performed with replacement, which is consistent with other distributions but non-standard for Empirical distributions. Use `simulateEmpiricalDistribution` to sample without replacement.

The cdf and quantile assumes that the elements are supplied in an indexed order (otherwise the results are meaningless).

**Value**

Returns an R6 object inheriting from class `SDistribution`.

**Distribution support**

The distribution is supported on \( x_1, ..., x_k \).

**Default Parameterisation**

Emp(samples = 1)

**Omitted Methods**

N/A

**Also known as**

N/A
Super classes

distr6::Distribution -> distr6::SDistribution -> Empirical

Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.

Methods

Public methods:

• Empirical$new()
• Empirical$mean()
• Empirical$mode()
• Empirical$variance()
• Empirical$skewness()
• Empirical$kurtosis()
• Empirical$entropy()
• Empirical$mgf()
• Empirical$cf()
• Empirical$pgf()
• Empirical$setParameterValue()
• Empirical$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Empirical$new(samples = NULL, decorators = NULL)

Arguments:
samples (numeric())
Vector of observed samples, see examples.
decorators (character())
Decorators to add to the distribution during construction.

Examples:
Empirical$new(runif(1000))

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

$$E_X(X) = \sum p_X(x) * x$$

with an integration analogue for continuous distributions.

Usage:
Empirical$mean(...)
Empirical

... Unused.

**Method** `mode()`: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

*Usage:*
`Empirical$mode(which = "all")`

*Arguments:*
- `which` (character(1) | numeric(1))
  - Ignored if distribution is unimodal. Otherwise “all” returns all modes, otherwise specifies which mode to return.

**Method** `variance()`: The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

*Usage:*
`Empirical$variance(...)`

*Arguments:*
... Unused.

**Method** `skewness()`: The skewness of a distribution is defined by the third standardised moment,

\[ sk_X = E_X \left[ \frac{x - \mu}{\sigma}^3 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

*Usage:*
`Empirical$skewness(...)`

*Arguments:*
... Unused.

**Method** `kurtosis()`: The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma}^4 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

*Usage:*
`Empirical$kurtosis(excess = TRUE, ...)`

*Arguments:*
- `excess` (logical(1))
  - If TRUE (default) excess kurtosis returned.
... Unused.
**Method entropy()**: The entropy of a (discrete) distribution is defined by

\[ -\sum (f_X) \log(f_X) \]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

*Usage:*

\[ \text{Empirical}\$\text{entropy(base = 2, ...)} \]

*Arguments:*

- `base` (integer(1))
  
  Base of the entropy logarithm, default = 2 (Shannon entropy)

... Unused.

**Method mgf()**: The moment generating function is defined by

\[ mgf_X(t) = E_X[\exp(\mathit{xt})] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

*Usage:*

\[ \text{Empirical}\$\text{mgf(t, ...)} \]

*Arguments:*

- `t` (integer(1))
  
  t integer to evaluate function at.

... Unused.

**Method cf()**: The characteristic function is defined by

\[ cf_X(t) = E_X[\exp(x \mathbf{i}t)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

*Usage:*

\[ \text{Empirical}\$\text{cf(t, ...)} \]

*Arguments:*

- `t` (integer(1))
  
  t integer to evaluate function at.

... Unused.

**Method pgf()**: The probability generating function is defined by

\[ pgf_X(z) = E_X[\exp(zx)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

*Usage:*

\[ \text{Empirical}\$\text{pgf(z, ...)} \]

*Arguments:*

- `z` (integer(1))
  
  z integer to evaluate probability generating function at.
Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
Empirical$setParameterValue(
....,
 lst = NULL,
 error = "warn",
 resolveConflicts = FALSE
)

Arguments:
... ANY
    Named arguments of parameters to set values for. See examples.
lst (list())
    Alternative argument for passing parameters. List names should be parameter names and
    list values are the new values to set.
error (character())
    If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical())
    If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
    tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Empirical$clone(deep = FALSE)

Arguments:
    deep Whether to make a deep clone.

References

Michael P. McLaughlin.

See Also

Other discrete distributions: Bernoulli, Binomial, Categorical, Degenerate, DiscreteUniform,
EmpiricalMV, Geometric, Hypergeometric, Logarithmic, Multinomial, NegativeBinomial,
WeightedDiscrete

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical,
Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Erlang, Exponential,
FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel,
Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal,
NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral,
StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete
EmpiricalMV

Examples

```r
## ------------------------------------------------
## Method `Empirical$new`
## ------------------------------------------------

Empirical$new(runif(1000))
```

**EmpiricalMV**  
*EmpiricalMV Distribution Class*

**Description**  
Mathematical and statistical functions for the EmpiricalMV distribution, which is commonly used in sampling such as MCMC.

**Details**  
The EmpiricalMV distribution is defined by the pmf,

\[ p(x) = \sum I(x = x_i)/k \]

for \( x_i \in R, i = 1, ..., k \).

Sampling from this distribution is performed with the `sample` function with the elements given as the support set and uniform probabilities. Sampling is performed with replacement, which is consistent with other distributions but non-standard for Empirical distributions. Use `simulateEmpiricalDistribution` to sample without replacement.

The cdf assumes that the elements are supplied in an indexed order (otherwise the results are meaningless).

**Value**  
Returns an R6 object inheriting from class `SDistribution`.

**Distribution support**  
The distribution is supported on \( x_1, ..., x_k \).

**Default Parameterisation**  
`EmpMV(data = data.frame(1, 1))`

**Omitted Methods**  
N/A
EmpiricalMV

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> EmpiricalMV

Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.

Methods

Public methods:

• EmpiricalMV$new()
• EmpiricalMV$mean()
• EmpiricalMV$variance()
• EmpiricalMV$setParameterValue()
• EmpiricalMV$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
EmpiricalMV$new(data = NULL, decorators = NULL)

Arguments:
data  [matrix]
  Matrix-like object where each column is a vector of observed samples corresponding to each variable.
decorators (character())
  Decorators to add to the distribution during construction.

Examples:
EmpiricalMV$new(MultivariateNormal$new()$rand(100))

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) \cdot x \]

with an integration analogue for continuous distributions.

Usage:
EmpiricalMV$mean(...)

Arguments:
... Unused.
**Method variance():** The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

**Usage:**
EmpiricalMV$variance(...)

**Arguments:**
... Unused.

**Method setParameterValue():** Sets the value(s) of the given parameter(s).

**Usage:**
EmpiricalMV$setParameterValue(..., lst = NULL, error = "warn", resolveConflicts = FALSE)

**Arguments:**
... ANY
   Named arguments of parameters to set values for. See examples.
lst (list(1))
   Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.
error (character(1))
   If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
   If FALSE (default) throws error if conflicting parameterisations are provided, otherwise automatically resolves them by removing all conflicting parameters.

**Method clone():** The objects of this class are cloneable with this method.

**Usage:**
EmpiricalMV$clone(deep = FALSE)

**Arguments:**
deepl Whether to make a deep clone.

**References**

**See Also**
Other discrete distributions: Bernoulli, Binomial, Categorical, Degenerate, DiscreteUniform, Empirical, Geometric, Hypergeometric, Logarithmic, Multinomial, NegativeBinomial, WeightedDiscrete
Other multivariate distributions: Dirichlet, Multinomial, MultivariateNormal
Examples

```r
## ------------------------------------------------
## Method `EmpiricalMV$new`
## ------------------------------------------------
EmpiricalMV$new(MultivariateNormal$new()$rand(100))
```

---

### entropy

**Distribution Entropy**

**Description**

(Information) Entropy of a distribution

**Usage**

```r
entropy(object, base = 2, ...)
```

**Arguments**

- `object`: Distribution.
- `base`: base of the entropy logarithm, default = 2 (Shannon entropy)
- `...`: Passed to `$genExp`.

**Value**

Entropy with given base as a numeric.

---

### Epanechnikov

**Epanechnikov Kernel**

**Description**

Mathematical and statistical functions for the Epanechnikov kernel defined by the pdf,

\[
f(x) = \frac{3}{4}(1 - x^2)
\]

over the support \( x \in (-1, 1) \).

**Details**

The quantile function is omitted as no closed form analytic expressions could be found, decorate with `FunctionImputation` for numeric results.
Super classes

distr6::Distribution -> distr6::Kernel -> Epanechnikov

Public fields

name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.

Methods

Public methods:

- Epanechnikov$pdfSquared2Norm()
- Epanechnikov$cdfSquared2Norm()
- Epanechnikov$variance()
- Epanechnikov$clone()

Method pdfSquared2Norm(): The squared 2-norm of the pdf is defined by
\[
\int_a^b (f_X(u))^2 du
\]
where X is the Distribution, \(f_X\) is its pdf and \(a, b\) are the distribution support limits.

Usage:
Epanechnikov$pdfSquared2Norm(x = 0, upper = Inf)

Arguments:
- x (numeric(1))  
  Amount to shift the result.
- upper (numeric(1))  
  Upper limit of the integral.

Method cdfSquared2Norm(): The squared 2-norm of the cdf is defined by
\[
\int_a^b (F_X(u))^2 du
\]
where X is the Distribution, \(F_X\) is its pdf and \(a, b\) are the distribution support limits.

Usage:
Epanechnikov$cdfSquared2Norm(x = 0, upper = 0)

Arguments:
- x (numeric(1))  
  Amount to shift the result.
- upper (numeric(1))  
  Upper limit of the integral.
Method variance(): The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
Epanechnikov$variance(...)

Arguments:
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Epanechnikov$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

See Also

Other kernels: Cosine, LogisticKernel, NormalKernel, Quartic, Sigmoid, Silverman, TriangularKernel, Tricube, Triweight, UniformKernel

Erlang

Erlang Distribution Class

Description

Mathematical and statistical functions for the Erlang distribution, which is commonly used as a special case of the Gamma distribution when the shape parameter is an integer.

Details

The Erlang distribution parameterised with shape, \( \alpha \), and rate, \( \beta \), is defined by the pdf,

\[ f(x) = (\beta^\alpha)(x^{\alpha-1})(\exp(-x/\beta))/(\alpha - 1)! \]

for \( \alpha = 1, 2, 3, \ldots \) and \( \beta > 0 \).

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on the Positive Reals.
Default Parameterisation

Erlang(shape = 1, rate = 1)

Omitted Methods

N/A

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> Erlang

Public fields

- name: Full name of distribution.
- short_name: Short name of distribution for printing.
- description: Brief description of the distribution.
- packages: Packages required to be installed in order to construct the distribution.

Methods

Public methods:

- Erlang$new()
- Erlang$mean()
- Erlang$mode()
- Erlang$variance()
- Erlang$skewness()
- Erlang$kurtosis()
- Erlang$entropy()
- Erlang$mgf()
- Erlang$cf()
- Erlang$pgf()
- Erlang$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Erlang$new(shape = NULL, rate = NULL, scale = NULL, decorators = NULL)

Arguments:
shape (integer(1))
	Shape parameter, defined on the positive Naturals.
rate (numeric(1))
	Rate parameter of the distribution, defined on the positive Reals.
scale numeric(1))
    Scale parameter of the distribution, defined on the positive Reals. scale = 1/rate. If
    provided rate is ignored.
decorators (character())
    Decorators to add to the distribution during construction.

**Method** `mean()`: The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) \times x \]

with an integration analogue for continuous distributions.

*Usage:*

`Erlang$mean(...)`

*Arguments:*

... Unused.

**Method** `mode()`: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

*Usage:*

`Erlang$mode(which = "all")`

*Arguments:*

which (character(1) | numeric(1)
    Ignored if distribution is unimodal. Otherwise “all” returns all modes, otherwise specifies
    which mode to return.

**Method** `variance()`: The variance of a distribution is defined by the formula

\[ var_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution X. If the distribution is multivariate the covariance
matrix is returned.

*Usage:*

`Erlang$variance(...)`

*Arguments:*

... Unused.

**Method** `skewness()`: The skewness of a distribution is defined by the third standardised moment,

\[ sk_X = E_X \left[ \frac{x - \mu^3}{\sigma} \right] \]

where \( E_X \) is the expectation of distribution X, \( \mu \) is the mean of the distribution and \( \sigma \) is the
standard deviation of the distribution.

*Usage:*

`Erlang$skewness(...)`

*Arguments:*

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X [\frac{x - \mu}{\sigma}^4] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
```
Erlang$kurtosis(excess = TRUE, ...)  
```

Arguments:
- excess (logical(1))
  - If TRUE (default) excess kurtosis returned.

Method entropy(): The entropy of a (discrete) distribution is defined by

\[ -\sum (f_X) \log(f_X) \]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
```
Erlang$entropy(base = 2, ...)  
```

Arguments:
- base (integer(1))
  - Base of the entropy logarithm, default = 2 (Shannon entropy)

Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X [exp(xt)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
```
Erlang$mgf(t, ...)  
```

Arguments:
- t (integer(1))
  - \( t \) integer to evaluate function at.

Method cf(): The characteristic function is defined by

\[ cf_X(t) = E_X [exp(xti)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
```
Erlang$cf(t, ...)  
```
**Erlang**

**Arguments:**
- $t$ (integer(1))
  - $t$ integer to evaluate function at.
- ... Unused.

**Method pgf():** The probability generating function is defined by

$$pgf_X(z) = E_X[exp(z^t)]$$

where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$.

**Usage:**
- Erlang$pgf(z, ...)$

**Arguments:**
- $z$ (integer(1))
  - $z$ integer to evaluate probability generating function at.
- ... Unused.

**Method clone():** The objects of this class are cloneable with this method.

**Usage:**
- Erlang$clone(deep = FALSE)$

**Arguments:**
- deep Whether to make a deep clone.

**References**


**See Also**

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Log Logistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete
exkurtosisType  Kurtosis Type

Description

Gets the type of (excess) kurtosis

Usage

exkurtosisType(kurtosis)

Arguments

kurtosis  numeric.

Details

Kurtosis is a measure of the tailedness of a distribution. Distributions can be compared to the Normal distribution by whether their kurtosis is higher, lower or the same as that of the Normal distribution.

A distribution with a negative excess kurtosis is called 'platykurtic', a distribution with a positive excess kurtosis is called 'leptokurtic' and a distribution with an excess kurtosis equal to zero is called 'mesokurtic'.

Value

Returns one of 'platykurtic', 'mesokurtic' or 'leptokurtic'.

See Also

kurtosis, skewType

Examples

exkurtosisType(-1)
exkurtosisType(0)
exkurtosisType(1)
Description

This decorator adds methods for more complex statistical methods including p-norms, survival and hazard functions and anti-derivatives. If possible analytical expressions are exploited, otherwise numerical ones are used with a message.

Details

Decorator objects add functionality to the given Distribution object by copying methods in the decorator environment to the chosen Distribution environment.

All methods implemented in decorators try to exploit analytical results where possible, otherwise numerical results are used with a message.

Super class

distr6::DistributionDecorator -> ExoticStatistics

Methods

Public methods:

- ExoticStatistics$cdfAntiDeriv()
- ExoticStatistics$survivalAntiDeriv()
- ExoticStatistics$survival()
- ExoticStatistics$hazard()
- ExoticStatistics$cumHazard()
- ExoticStatistics$survivalPNorm()
- ExoticStatistics$pdfPNorm()
- ExoticStatistics$cdfPNorm()
- ExoticStatistics$clone()

Method cdfAntiDeriv(): The cdf anti-derivative is defined by

\[ acdf(a, b) = \int_a^b F_X(x) \, dx \]

where \( X \) is the distribution, \( F_X \) is the cdf of the distribution \( X \) and \( a, b \) are the lower and upper limits of integration.

Usage:

ExoticStatistics$cdfAntiDeriv(lower = NULL, upper = NULL)

Arguments:

lower (numeric(1))

Lower bounds of integral.
upper (numeric(1))
  Upper bounds of integral.

Method survivalAntiDeriv(): The survival anti-derivative is defined by

\[ as(a, b) = \int_a^b S_X(x)\,dx \]

where \( X \) is the distribution, \( S_X \) is the survival function of the distribution \( X \) and \( a, b \) are the lower and upper limits of integration.

Usage:
ExoticStatistics$survivalAntiDeriv(lower = NULL, upper = NULL)

Arguments:
lower (numeric(1))
  Lower bounds of integral.
upper (numeric(1))
  Upper bounds of integral.

Method survival(): The survival function is defined by

\[ S_X(x) = P(X \geq x) = 1 - F_X(x) = \int_x^\infty f_X(x)\,dx \]

where \( X \) is the distribution, \( S_X \) is the survival function, \( F_X \) is the cdf and \( f_X \) is the pdf.

Usage:
ExoticStatistics$survival(..., log = FALSE, simplify = TRUE, data = NULL)

Arguments:
... (numeric())
  Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.
log (logical(1))
  If TRUE returns the logarithm of the probabilities. Default is FALSE.
simplify logical(1)
  If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.
data array
  Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

Method hazard(): The hazard function is defined by

\[ h_X(x) = \frac{f_X}{S_X} \]

where \( X \) is the distribution, \( S_X \) is the survival function and \( f_X \) is the pdf.

Usage:
ExoticStatistics$hazard(..., log = FALSE, simplify = TRUE, data = NULL)

**Arguments:**

... (numeric())

Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

log (logical(1))

If TRUE returns the logarithm of the probabilities. Default is FALSE.

simplify logical(1)

If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.

data array

Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

**Method cumHazard():** The cumulative hazard function is defined analytically by

\[ H_X(x) = -\log(S_X) \]

where \( X \) is the distribution and \( S_X \) is the survival function.

**Usage:**

ExoticStatistics$cumHazard(..., log = FALSE, simplify = TRUE, data = NULL)

**Arguments:**

... (numeric())

Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

log (logical(1))

If TRUE returns the logarithm of the probabilities. Default is FALSE.

simplify logical(1)

If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.

data array

Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

**Method cdfPNorm():** The p-norm of the cdf is defined by

\[ \left( \int_a^b |F_X|^{p} d\mu \right)^{1/p} \]

where \( X \) is the distribution, \( F_X \) is the cdf and \( a, b \) are the lower and upper limits of integration. Returns NULL if distribution is not continuous.

**Usage:**

ExoticStatistics$cdfPNorm(p = 2, lower = NULL, upper = NULL)
Arguments:
p (integer(1)) Norm to evaluate.
lower (numeric(1))
    Lower bounds of integral.
upper (numeric(1))
    Upper bounds of integral.

Method pdfPNorm(): The p-norm of the pdf is defined by

\[
\left( \int_a^b |f_X|^p d\mu \right)^{1/p}
\]

where X is the distribution, \( f_X \) is the pdf and \( a, b \) are the lower and upper limits of integration. Returns NULL if distribution is not continuous.

Usage:
ExoticStatistics$pdfPNorm(p = 2, lower = NULL, upper = NULL)

Arguments:
p (integer(1)) Norm to evaluate.
lower (numeric(1))
    Lower bounds of integral.
upper (numeric(1))
    Upper bounds of integral.

Method survivalPNorm(): The p-norm of the survival function is defined by

\[
\left( \int_a^b |S_X|^p d\mu \right)^{1/p}
\]

where X is the distribution, \( S_X \) is the survival function and \( a, b \) are the lower and upper limits of integration. Returns NULL if distribution is not continuous.

Usage:
ExoticStatistics$survivalPNorm(p = 2, lower = NULL, upper = NULL)

Arguments:
p (integer(1)) Norm to evaluate.
lower (numeric(1))
    Lower bounds of integral.
upper (numeric(1))
    Upper bounds of integral.

Method clone(): The objects of this class are cloneable with this method.

Usage:
ExoticStatistics$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.
Exponential

**Description**

Mathematical and statistical functions for the Exponential distribution, which is commonly used to model inter-arrival times in a Poisson process and has the memoryless property.

**Details**

The Exponential distribution parameterised with rate, $\lambda$, is defined by the pdf,

$$f(x) = \lambda e^{-\lambda x}$$

for $\lambda > 0$.

**Value**

Returns an R6 object inheriting from class SDistribution.

**Distribution support**

The distribution is supported on the Positive Reals.

**Default Parameterisation**

Exp(rate = 1)

**Omitted Methods**

N/A

**Also known as**

N/A

**Super classes**

`distr6::Distribution` -> `distr6::SDistribution` -> Exponential

---

**See Also**

Other decorators: CoreStatistics, FunctionImputation

**Examples**

```r
decorate(Exponential$new(), "ExoticStatistics")
Exponential$new(decorators = "ExoticStatistics")
ExoticStatistics$new()$decorate(Exponential$new())
```
Public fields

name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.

Methods

Public methods:

- Exponential$new()
- Exponential$mean()
- Exponential$mode()
- Exponential$median()
- Exponential$variance()
- Exponential$skewness()
- Exponential$kurtosis()
- Exponential$entropy()
- Exponential$mgf()
- Exponential$cf()
- Exponential$pgf()
- Exponential$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Exponential$new(rate = NULL, scale = NULL, decorators = NULL)

Arguments:
rate (numeric(1))
Rate parameter of the distribution, defined on the positive Reals.
scale numeric(1))
Scale parameter of the distribution, defined on the positive Reals. scale = 1/rate. If provided rate is ignored.
decorators (character())
Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) \cdot x \]

with an integration analogue for continuous distributions.

Usage:
Exponential$mean(...)

Arguments:
... Unused.
**Method** `mode()`: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

*Usage:*

Exponential$mode(which = "all")

*Arguments:*

which (character(1) | numeric(1))

- Ignored if distribution is unimodal. Otherwise “all” returns all modes, otherwise specifies which mode to return.

**Method** `median()`: Returns the median of the distribution. If an analytical expression is available returns distribution median, otherwise if symmetric returns `self$mean`, otherwise returns `self$quantile(0.5)`.

*Usage:*

Exponential$median()

**Method** `variance()`: The variance of a distribution is defined by the formula

$$\text{var}_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution $X$. If the distribution is multivariate the covariance matrix is returned.

*Usage:*

Exponential$variance(...)

*Arguments:*

... Unused.

**Method** `skewness()`: The skewness of a distribution is defined by the third standardised moment,

$$sk_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution.

*Usage:*

Exponential$skewness(...)

*Arguments:*

... Unused.

**Method** `kurtosis()`: The kurtosis of a distribution is defined by the fourth standardised moment,

$$k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

*Usage:*

Exponential$kurtosis(excess = TRUE, ...*)
Exponential

Arguments:
excess (logical(1))
    If TRUE (default) excess kurtosis returned.
    ... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by

\[- \sum (f_X) \log(f_X)\]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
Exponential$entropy(base = 2, ...)

Arguments:
base (integer(1))
    Base of the entropy logarithm, default = 2 (Shannon entropy)
    ... Unused.

Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X[\exp(xt)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Exponential$mgf(t, ...)

Arguments:
t (integer(1))
    t integer to evaluate function at.
    ... Unused.

Method cf(): The characteristic function is defined by

\[ cf_X(t) = E_X[\exp(xti)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Exponential$cf(t, ...)

Arguments:
t (integer(1))
    t integer to evaluate function at.
    ... Unused.

Method pgf(): The probability generating function is defined by

\[ pgf_X(z) = E_X[\exp(zx)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Exponential$pgf(z, ...)$

Arguments:
z (integer(1))
  z integer to evaluate probability generating function at.
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Exponential$clone(deep = FALSE)$

Arguments:
deep Whether to make a deep clone.

References

See Also
Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull
Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

FDistribution 'F' Distribution Class

Description
Mathematical and statistical functions for the 'F' distribution, which is commonly used in ANOVA testing and is the ratio of scaled Chi-Squared distributions.

Details
The 'F' distribution parameterised with two degrees of freedom parameters, $\mu, \nu$, is defined by the pdf,

$$f(x) = \frac{\Gamma((\mu + \nu)/2)/\Gamma(\nu/2)}{(\mu/\nu)^{\mu/2}2^{\mu/2-1}(1 + (\mu/\nu)x)^{-(\mu+\nu)/2}}$$

for $\mu, \nu > 0$. 
Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on the Positive Reals.

Default Parameterisation

F(df1 = 1, df2 = 1)

Omitted Methods

N/A

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> FDistribution

Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.
packages  Packages required to be installed in order to construct the distribution.

Methods

Public methods:

• FDistribution$new()
• FDistribution$mean()
• FDistribution$mode()
• FDistribution$variance()
• FDistribution$skewness()
• FDistribution$kurtosis()
• FDistribution$entropy()
• FDistribution$mgf()
• FDistribution$pgf()
• FDistribution$setParameterValue()
• FDistribution$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
FDistribution\$new(df1 = NULL, df2 = NULL, decorators = NULL)

Arguments:
df1 (numeric(1))
First degree of freedom of the distribution defined on the positive Reals.
df2 (numeric(1))
Second degree of freedom of the distribution defined on the positive Reals.
decorators (character())
Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) * x \]

with an integration analogue for continuous distributions.

Usage:
FDistribution\$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
FDistribution\$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula

\[ var_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

Usage:
FDistribution\$variance(...)

Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

\[ sk_X = E_X \left[ \frac{x - \mu^3}{\sigma} \right] \]

where \( E_X \) is the expectation of distribution X, \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.
Usage:
FDistribution$skewness(...)

Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

$$k_X = E_X \left[ \frac{x - \mu}{\sigma}^4 \right]$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
FDistribution$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))
  If TRUE (default) excess kurtosis returned.
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by

$$- \sum (f_X) \log(f_X)$$

where $f_X$ is the pdf of distribution $X$, with an integration analogue for continuous distributions.

Usage:
FDistribution$entropy(base = 2, ...)

Arguments:
base (integer(1))
  Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method mgf(): The moment generating function is defined by

$$mgf_X(t) = E_X[exp(x t)]$$

where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$.

Usage:
FDistribution$mgf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Unused.

Method pgf(): The probability generating function is defined by

$$pgf_X(z) = E_X[exp(z x)]$$

where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$. 
Usage:
FDistribution$pgf(z, ...)

Arguments:
z (integer(1))
  z integer to evaluate probability generating function at.
...
  Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).
Usage:
FDistribution$setParameterValue(
  ..., 
  lst = NULL,
  error = "warn",
  resolveConflicts = FALSE
)

Arguments:
...
  ANY
    Named arguments of parameters to set values for. See examples.
  lst (list(1))
    Alternative argument for passing parameters. List names should be parameter names and
    list values are the new values to set.
  error (character(1))
    If "warn" then returns a warning on error, otherwise breaks if "stop".
  resolveConflicts (logical(1))
    If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
    tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.
Usage:
FDistribution$clone(deep = FALSE)

Arguments:
  deep  Whether to make a deep clone.

References
Michael P. McLaughlin.

See Also
Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral,
  ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, Frechet, Gamma,
  Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal,
  Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT,
  Triangular, Uniform, Wald, Weibull
Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

FDistributionNoncentral

Noncentral F Distribution Class

Description
Mathematical and statistical functions for the Noncentral F distribution, which is commonly used in ANOVA testing and is the ratio of scaled Chi-Squared distributions.

Details
The Noncentral F distribution parameterised with two degrees of freedom parameters, \( \mu, \nu \), and location, \( \lambda \). is defined by the pdf,

\[
f(x) = \sum_{r=0}^{\infty} \left( \left( \frac{e^{-\lambda/2}(\lambda/2)^r}{(\nu/2, \mu/2+r)!(\mu/\nu)^{\mu/2+r} r^{\mu+\nu} (\nu+x\mu)^{(\mu+\nu)/2+r}} \right) \right)
\]

for \( \mu, \nu > 0, \lambda \geq 0. \)

Value
Returns an R6 object inheriting from class SDistribution.

Distribution support
The distribution is supported on the Positive Reals.

Default Parameterisation
FNC(df1 = 1, df2 = 1, location = 0)

Omitted Methods
N/A

Also known as
N/A

Super classes
\[\text{distr6::Distribution} \rightarrow \text{distr6::SDistribution} \rightarrow \text{FDistributionNoncentral}\]
Public fields

- name Full name of distribution.
- short_name Short name of distribution for printing.
- description Brief description of the distribution.
- packages Packages required to be installed in order to construct the distribution.

Methods

Public methods:

- `FDistributionNoncentral$new()`
- `FDistributionNoncentral$mean()`
- `FDistributionNoncentral$variance()`
- `FDistributionNoncentral$setParameterValue()`
- `FDistributionNoncentral$clone()`

Method `new()`: Creates a new instance of this R6 class.

Usage:

```r
FDistributionNoncentral$new(
  df1 = NULL,
  df2 = NULL,
  location = NULL,
  decorators = NULL
)
```

Arguments:

- `df1` (numeric(1))
  - First degree of freedom of the distribution defined on the positive Reals.
- `df2` (numeric(1))
  - Second degree of freedom of the distribution defined on the positive Reals.
- `location` (numeric(1))
  - Location parameter, defined on the Reals.
- `decorators` (character())
  - Decorators to add to the distribution during construction.

Method `mean()`: The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

$$E_X(X) = \sum p_X(x) * x$$

with an integration analogue for continuous distributions.

Usage:

```r
FDistributionNoncentral$mean(...)```

Arguments:

- ... Unused.
Method variance(): The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
FDistributionNoncentral$variance(...)

Arguments:
... Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
FDistributionNoncentral$setParameterValue(
  ...,
  lst = NULL,
  error = "warn",
  resolveConflicts = FALSE
)

Arguments:
... ANY
  Named arguments of parameters to set values for. See examples.
  lst (list(1))
    Alternative argument for passing parameters. List names should be parameter names and
    list values are the new values to set.
  error (character(1))
    If "warn" then returns a warning on error, otherwise breaks if "stop".
  resolveConflicts (logical(1))
    If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
    tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
FDistributionNoncentral$clone(deep = FALSE)

Arguments:
  deep Whether to make a deep clone.

Author(s)
Jordan Deenichin

References
Michael P. McLaughlin.
See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

<table>
<thead>
<tr>
<th>Frechet</th>
<th>Frechet Distribution Class</th>
</tr>
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</table>

Description

Mathematical and statistical functions for the Frechet distribution, which is commonly used as a special case of the Generalised Extreme Value distribution.

Details

The Frechet distribution parameterised with shape, \( \alpha \), scale, \( \beta \), and minimum, \( \gamma \), is defined by the pdf,

\[
f(x) = \frac{\alpha}{\beta} \left( \frac{x - \gamma}{\beta} \right)^{-1-\alpha} \exp\left(-\frac{x - \gamma}{\beta}\right)^{-\alpha}
\]

for \( \alpha, \beta \in R^+ \) and \( \gamma \in R \).

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on \( x > \gamma \).

Default Parameterisation

Frec(shape = 1, scale = 1, minimum = 0)

Omitted Methods

N/A

Also known as

Also known as the Inverse Weibull distribution.
Super classes

\[
distr6::Distribution \rightarrow distr6::SDistribution \rightarrow \text{Frechet}
\]

Public fields

- \text{name} Full name of distribution.
- \text{short_name} Short name of distribution for printing.
- \text{description} Brief description of the distribution.
- \text{packages} Packages required to be installed in order to construct the distribution.

Methods

Public methods:

- \text{Frechet$new()}
- \text{Frechet$mean()}
- \text{Frechet$mode()}
- \text{Frechet$median()}
- \text{Frechet$variance()}
- \text{Frechet$skewness()}
- \text{Frechet$kurtosis()}
- \text{Frechet$entropy()}
- \text{Frechet$pgf()}
- \text{Frechet$setParameterValue()}
- \text{Frechet$clone()}

Method \text{new()}: Creates a new instance of this \text{R6} class.

\text{Usage:}

\text{Frechet$new(shape = NULL, scale = NULL, minimum = NULL, decorators = NULL)}

\text{Arguments:}

- \text{shape (numeric(1))}
  Shape parameter, defined on the positive Reals.
- \text{scale (numeric(1))}
  Scale parameter, defined on the positive Reals.
- \text{minimum (numeric(1))}
  Minimum of the distribution, defined on the Reals.
- \text{decorators (character())}
  Decorators to add to the distribution during construction.

Method \text{mean()}: The arithmetic mean of a (discrete) probability distribution \( X \) is the expectation

\[
E_X(X) = \sum p_X(x) \ast x
\]

with an integration analogue for continuous distributions.

\text{Usage:}
Frechet$mean(...)  
*Arguments*: ... Unused.  

**Method** mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).  
*Usage*:  
Frechet$mode(which = "all")  
*Arguments*:  
which (character(1) | numeric(1))  
Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.  

**Method** median(): Returns the median of the distribution. If an analytical expression is available returns distribution median, otherwise if symmetric returns self$mean, otherwise returns self$quantile(0.5).  
*Usage*:  
Frechet$median()  

**Method** variance(): The variance of a distribution is defined by the formula  
\[ \text{var}_X = E[X^2] - E[X]^2 \]  
where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.  
*Usage*:  
Frechet$variance(...)  
*Arguments*: ... Unused.  

**Method** skewness(): The skewness of a distribution is defined by the third standardised moment,  
\[ \text{sk}_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]  
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.  
*Usage*:  
Frechet$skewness(...)  
*Arguments*: ... Unused.  

**Method** kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,  
\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]  
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.
Usage:
Frechet$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))
   If TRUE (default) excess kurtosis returned.
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by

\[- \sum (f_X) \log(f_X)\]

where $f_X$ is the pdf of distribution X, with an integration analogue for continuous distributions.

Usage:
Frechet$entropy(base = 2, ...)

Arguments:
base (integer(1))
   Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method pgf(): The probability generating function is defined by

$$pgf_X(z) = E_X[exp(z^z)]$$

where X is the distribution and $E_X$ is the expectation of the distribution X.

Usage:
Frechet$pgf(z, ...)

Arguments:
z (integer(1))
   z integer to evaluate probability generating function at.
... Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
Frechet$setParameterValue(..., 
   ..., 
   lst = NULL, 
   error = "warn", 
   resolveConflicts = FALSE
)

Arguments:
... ANY
   Named arguments of parameters to set values for. See examples.
lst (list(1))
   Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.
error (character(1))
   If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
   If FALSE (default) throws error if conflicting parameterisations are provided, otherwise auto-
   matically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.
   Usage:
   Frechet$clone(deep = FALSE)
   Arguments:
   deep Whether to make a deep clone.

References

   Michael P. McLaughlin.

See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral,
   ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution,
   Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal,
   MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT,
   Triangular, Uniform, Wald, Weibull
Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical,
   Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang,
   Exponential, FDistributionNoncentral, FDistribution, Gamma, Geometric, Gompertz, Gumbel,
   Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal,
   NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral,
   StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

FunctionImputation          Imputed Pdf/Cdf/Quantile/Rand Functions Decorator

Description

This decorator imputes missing pdf/cdf/quantile/rand methods from R6 Distributions by using
strategies dependent on which methods are already present in the distribution. Unlike other deco-
rators, private methods are added to the Distribution, not public methods. Therefore the underly-
functions stay the same.

Details

Decorator objects add functionality to the given Distribution object by copying methods in the
decorator environment to the chosen Distribution environment.
All methods implemented in decorators try to exploit analytical results where possible, otherwise
numerical results are used with a message.
Super class

distr6::DistributionDecorator -> FunctionImputation

Public fields

packages  Packages required to be installed in order to construct the distribution.

Active bindings

methods  Returns the names of the available methods in this decorator.

Methods

Public methods:

- FunctionImputation$decorate()
- FunctionImputation$clone()

Method decorate(): Decorates the given distribution with the methods available in this decorator.

Usage:
FunctionImputation$decorate(distribution, n = 1000)

Arguments:

distribution  Distribution
  Distribution to decorate.

n (integer(1))
  Grid size for imputing functions, cannot be changed after decorating. Generally larger n
  means better accuracy but slower computation, and smaller n means worse accuracy and
  faster computation.

Method clone(): The objects of this class are cloneable with this method.

Usage:
FunctionImputation$clone(deep = FALSE)

Arguments:

deep  Whether to make a deep clone.

See Also

Other decorators: CoreStatistics, ExoticStatistics

Examples

if (requireNamespace("GoFKernel", quietly = TRUE) &
  requireNamespace("pracma", quietly = TRUE)) {
  pdf <- function(x) ifelse(x < 1 | x > 10, 0, 1 / 10)
  x <- Distribution$new("Test",
    pdf = pdf,
support = set6::Interval$new(1, 10, class = "integer"),
type = set6::Naturals$new()
)
decorate(x, "FunctionImputation", n = 1000)

x <- Distribution$new("Test",
  pdf = pdf,
  support = set6::Interval$new(1, 10, class = "integer"),
  type = set6::Naturals$new(),
  decorators = "FunctionImputation"
)

x$pdf(1:10)
x$cdf(1:10)
x$quantile(0.42)
x$rand(4)
}

——

**Gamma**

**Gamma Distribution Class**

**Description**

Mathematical and statistical functions for the Gamma distribution, which is commonly used as the prior in Bayesian modelling, the convolution of exponential distributions, and to model waiting times.

**Details**

The Gamma distribution parameterised with shape, $\alpha$, and rate, $\beta$, is defined by the pdf,

$$f(x) = (\beta^\alpha)/\Gamma(\alpha)x^{\alpha-1}exp(-x\beta)$$

for $\alpha, \beta > 0$.

**Value**

Returns an R6 object inheriting from class `SDistribution`.

**Distribution support**

The distribution is supported on the Positive Reals.
Default Parameterisation

Gamma(shape = 1, rate = 1)

Omitted Methods

N/A

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> Gamma

Public fields

name  Full name of distribution.
short.name  Short name of distribution for printing.
description  Brief description of the distribution.
packages  Packages required to be installed in order to construct the distribution.

Methods

Public methods:

• Gamma$new()
• Gamma$mean()
• Gamma$mode()
• Gamma$variance()
• Gamma$skewness()
• Gamma$kurtosis()
• Gamma$entropy()
• Gamma$mgf()
• Gamma$cf()
• Gamma$pgf()
• Gamma$clone()

Method new(): Creates a new instance of this R6 class.

Usage:

Gamma$new(
  shape = NULL,
  rate = NULL,
  scale = NULL,
  mean = NULL,
  decorators = NULL
)
Arguments:

shape (numeric(1))
    Shape parameter, defined on the positive Reals.
rate (numeric(1))
    Rate parameter of the distribution, defined on the positive Reals.
scale numeric(1))
    Scale parameter of the distribution, defined on the positive Reals. scale = 1/rate. If provided rate is ignored.
mean (numeric(1))
    Alternative parameterisation of the distribution, defined on the positive Reals. If given then rate and scale are ignored. Related by mean = shape/rate.
decorators (character())
    Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) \cdot x \]

with an integration analogue for continuous distributions.

Usage:
Gamma$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Gamma$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
    Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula

\[ var_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

Usage:
Gamma$variance(...)

Arguments:
... Unused.
Method \texttt{skewness()}: The skewness of a distribution is defined by the third standardised moment,

\[ sk_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
\texttt{Gamma$skewness(...)}

Arguments:
... Unused.

Method \texttt{kurtosis()}: The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
\texttt{Gamma$kurtosis(excess = TRUE, ...)}

Arguments:
\texttt{excess (logical(1))}
  - If \( \text{TRUE} \) (default) excess kurtosis returned.
... Unused.

Method \texttt{entropy()}: The entropy of a (discrete) distribution is defined by

\[ - \sum (f_X) \log(f_X) \]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
\texttt{Gamma$entropy(base = 2, ...)}

Arguments:
\texttt{base (integer(1))}
  - Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method \texttt{mgf()}: The moment generating function is defined by

\[ mgf_X(t) = E_X[\exp(\mu t)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
\texttt{Gamma$mgf(t, ...)}

Arguments:
Method \( \text{cf}() \): The characteristic function is defined by

\[
\text{cf}_X(t) = \mathbb{E}_X[\exp(\text{t}i)]
\]

where \( X \) is the distribution and \( \mathbb{E}_X \) is the expectation of the distribution \( X \).

Usage:
\[
\text{Gamma}\text{cf}(t, \ldots)
\]

Arguments:
- \( t \) (integer(1))
  - \( t \) integer to evaluate function at.
- ... Unused.

Method \( \text{pgf}() \): The probability generating function is defined by

\[
\text{pgf}_X(z) = \mathbb{E}_X[\exp(z^x)]
\]

where \( X \) is the distribution and \( \mathbb{E}_X \) is the expectation of the distribution \( X \).

Usage:
\[
\text{Gamma}\text{pgf}(z, \ldots)
\]

Arguments:
- \( z \) (integer(1))
  - \( z \) integer to evaluate probability generating function at.
- ... Unused.

Method \( \text{clone}() \): The objects of this class are cloneable with this method.

Usage:
\[
\text{Gamma}\text{clone}(\text{deep} = \text{FALSE})
\]

Arguments:
- \( \text{deep} \) Whether to make a deep clone.

References


See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull
Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

---

**generalPNorm**

**Generalised P-Norm**

**Description**

Calculate the p-norm of any function between given limits.

**Usage**

```r
generalPNorm(fun, p, lower, upper, range = NULL)
```

**Arguments**

- `fun`: function to calculate the p-norm of.
- `p`: the pth norm to calculate
- `lower`: lower bound for the integral
- `upper`: upper bound for the integral
- `range`: if discrete then range of the function to sum over

**Details**

The p-norm of a continuous function \( f \) is given by,

\[
\left( \int_S |f|^p d\mu \right)^{1/p}
\]

where \( S \) is the function support. And for a discrete function by

\[
\sum_i (x_{i+1} - x_i) \cdot |f(x_i)|^p
\]

where \( i \) is over a given range.

The p-norm is calculated numerically using the `integrate` function and therefore results are approximate only.

**Value**

Returns a numeric value for the p norm of a function evaluated between given limits.

**Examples**

```r
generalPNorm(Exponential$new()$pdf, 2, 0, 10)
```
**genExp**

*Generalised Expectation of a Distribution*

**Description**

A generalised expectation function for distributions, for arithmetic mean and more complex numeric calculations.

**Usage**

```r
genExp(object, trafo = NULL, cubature = FALSE, ...)
```

**Arguments**

- `object`: Distribution.
- `trafo`: transformation for expectation calculation, see details.
- `cubature`: If TRUE uses `cubature::cubintegrate` for approximation, otherwise `integrate`.
- `...`: Passed to `cubature::cubintegrate`.

**Value**

The given expectation as a numeric, otherwise NULL.

---

**Geometric**

*Geometric Distribution Class*

**Description**

Mathematical and statistical functions for the Geometric distribution, which is commonly used to model the number of trials (or number of failures) before the first success.

**Details**

The Geometric distribution parameterised with probability of success, $p$, is defined by the pmf,

$$f(x) = (1 - p)^{x-1}p$$

for probability $p$.

The Geometric distribution is used to either refer to modelling the number of trials or number of failures before the first success.

**Value**

Returns an R6 object inheriting from class `SDistribution`. 
Geometric Distribution support

The distribution is supported on the Naturals (zero is included if modelling number of failures before success).

Default Parameterisation

Geom(prob = 0.5, trials = FALSE)

Omitted Methods

N/A

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> Geometric

Public fields

name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.

Methods

Public methods:

• Geometric$new()
• Geometric$mean()
• Geometric$mode()
• Geometric$variance()
• Geometric$skewness()
• Geometric$kurtosis()
• Geometric$entropy()
• Geometric$mgf()
• Geometric$cf()
• Geometric$pgf()
• Geometric$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Geometric$new(prob = NULL, qprob = NULL, trials = NULL, decorators = NULL)

Arguments:
prob (numeric(1))
  Probability of success.
qprob (numeric(1))
  Probability of failure. If provided then prob is ignored. qprob = 1 - prob.
trials (logical(1))
  If TRUE then the distribution models the number of trials, \( x \), before the first success. Otherwise the distribution calculates the probability of \( y \) failures before the first success. Mathematically these are related by \( Y = X - 1 \).
decorators (character())
  Decorators to add to the distribution during construction.

**Method** mean(): The arithmetic mean of a (discrete) probability distribution \( X \) is the expectation

\[
E_X(X) = \sum p_X(x) \cdot x
\]

with an integration analogue for continuous distributions.

*Usage:*
Geometric$mean(...)

*Arguments:*
... Unused.

**Method** mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

*Usage:*
Geometric$mode(which = "all")

*Arguments:*
which (character(1) | numeric(1))
  Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

**Method** variance(): The variance of a distribution is defined by the formula

\[
var_X = E[X^2] - E[X]^2
\]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

*Usage:*
Geometric$variance(...)

*Arguments:*
... Unused.

**Method** skewness(): The skewness of a distribution is defined by the third standardised moment,

\[
sk_X = E_X \left( \frac{x - \mu}{\sigma} \right)^3
\]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.
**Usage:**
Geometric$skewness(...)

**Arguments:**
... Unused.

**Method kurtosis():** The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = \frac{E_X\left(\frac{X - \mu}{\sigma}\right)^4}{\sigma^4} \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

**Usage:**
Geometric$kurtosis(excess = TRUE, ...)

**Arguments:**
excess (logical(1))
   If TRUE (default) excess kurtosis returned.
... Unused.

**Method entropy():** The entropy of a (discrete) distribution is defined by

\[ -\sum (f_X)\log(f_X) \]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

**Usage:**
Geometric$entropy(base = 2, ...)

**Arguments:**
base (integer(1))
   Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

**Method mgf():** The moment generating function is defined by

\[ mgf_X(t) = E_X[exp(xt)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

**Usage:**
Geometric$mgf(t, ...)

**Arguments:**
t (integer(1))
   t integer to evaluate function at.
... Unused.

**Method cf():** The characteristic function is defined by

\[ cf_X(t) = E_X[exp(xti)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).
Usage:
Geometric$cf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Unused.

Method pgf(): The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(z^x)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Geometric$pgf(z, ...)

Arguments:
z (integer(1))
  z integer to evaluate probability generating function at.
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Geometric$clone(deep = FALSE)

Arguments:
deept Whetether to make a deep clone.

References


See Also

Other discrete distributions: Bernoulli, Binomial, Categorical, Degenerate, DiscreteUniform, EmpiricalMV, Empirical, Hypergeometric, Logarithmic, Multinomial, NegativeBinomial, WeightedDiscrete

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete
getParameterSupport  Parameter Support Accessor

Description

Returns the support of the given parameter.

Usage

getParameterSupport(object, id, error = "warn")

Arguments

object  Distribution or ParameterSet.
id  character, id of the parameter to return.
error  character, value to pass to stopwarn.

Value

An R6 object of class inheriting from set6::Set

generateParameter

getParameterValue  Parameter Value Accessor

Description

Returns the value of the given parameter.

Usage

getParameterValue(object, id, error = "warn")

Arguments

object  Distribution or ParameterSet.
id  character, id of the parameter to return.
error  character, value to pass to stopwarn.

Value

The current value of a given parameter as a numeric.
**Gompertz Distribution Class**

**Description**
Mathematical and statistical functions for the Gompertz distribution, which is commonly used in survival analysis particularly to model adult mortality rates.

**Details**
The Gompertz distribution parameterised with shape, $\alpha$, and scale, $\beta$, is defined by the pdf,

$$f(x) = \alpha \beta \exp(x\beta) \exp(\alpha \exp(-\exp(x\beta)\alpha))$$

for $\alpha, \beta > 0$.

**Value**
Returns an R6 object inheriting from class `SDistribution`.

**Distribution support**
The distribution is supported on the Non-Negative Reals.

**Default Parameterisation**
`Gomp(shape = 1, scale = 1)`

**Omitted Methods**
N/A

**Also known as**
N/A

**Super classes**
`distr6::Distribution` -> `distr6::SDistribution` -> `Gompertz`

**Public fields**
- `name` Full name of distribution.
- `short_name` Short name of distribution for printing.
- `description` Brief description of the distribution.
- `packages` Packages required to be installed in order to construct the distribution.
Methods

Public methods:
- Gompertz$new()
- Gompertz$median()
- Gompertz$pgf()
- Gompertz$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Gompertz$new(shape = NULL, scale = NULL, decorators = NULL)

Arguments:
- shape (numeric(1))
  Shape parameter, defined on the positive Reals.
- scale (numeric(1))
  Scale parameter, defined on the positive Reals.
- decorators (character())
  Decorators to add to the distribution during construction.

Method median(): Returns the median of the distribution. If an analytical expression is available returns distribution median, otherwise if symmetric returns self$mean, otherwise returns self$quantile(0.5).

Usage:
Gompertz$median()

Method pgf(): The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(z^x)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X.

Usage:
Gompertz$pgf(z, ...)

Arguments:
- z (integer(1))
  z integer to evaluate probability generating function at.
- ... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Gompertz$clone(deep = FALSE)

Arguments:
- deep Whether to make a deep clone.

References

Gumbel

See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

---

**Gumbel**

**Gumbel Distribution Class**

Description

Mathematical and statistical functions for the Gumbel distribution, which is commonly used to model the maximum (or minimum) of a number of samples of different distributions, and is a special case of the Generalised Extreme Value distribution.

Details

The Gumbel distribution parameterised with location, \( \mu \), and scale, \( \beta \), is defined by the pdf,

\[
f(x) = \exp(-(z + \exp(-z)))/\beta
\]

for \( z = (x - \mu)/\beta, \mu \in \mathbb{R} \) and \( \beta > 0 \).

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on the Reals.

Default Parameterisation

Gumb(location = 0, scale = 1)

Omitted Methods

N/A
Also known as
N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> Gumbel

Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.
packages  Packages required to be installed in order to construct the distribution.

Methods

Public methods:

• Gumbel$new()
• Gumbel$mean()
• Gumbel$mode()
• Gumbel$median()
• Gumbel$variance()
• Gumbel$skewness()
• Gumbel$kurtosis()
• Gumbel$entropy()
• Gumbel$mgf()
• Gumbel$cf()
• Gumbel$pgf()
• Gumbel$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Gumbel$new(location = NULL, scale = NULL, decorators = NULL)

Arguments:
location (numeric(1))
  Location parameter defined on the Reals.
scale (numeric(1))
  Scale parameter defined on the positive Reals.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) * x \]

with an integration analogue for continuous distributions.
Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Gumbel$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method median(): Returns the median of the distribution. If an analytical expression is available returns distribution median, otherwise if symmetric returns self$mean, otherwise returns self$quantile(0.5).

Usage:
Gumbel$median()

Method variance(): The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
Gumbel$variance(...) 

Arguments: 
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

\[ \text{sk}_X = E_X\left[ \frac{x - \mu}{\sigma}^3 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.
Apery's Constant to 16 significant figures is used in the calculation.

Usage:
Gumbel$skewness(...) 

Arguments: 
... Unused.
**Method** kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]

where \( E_X \) is the expectation of distribution X, \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

*Usage:*

Gumbel$kurtosis(excess = TRUE, ...)

*Arguments:*

excess (logical(1))

If TRUE (default) excess kurtosis returned.

... Unused.

**Method** entropy(): The entropy of a (discrete) distribution is defined by

\[-\sum (f_X) log(f_X)\]

where \( f_X \) is the pdf of distribution X, with an integration analogue for continuous distributions.

*Usage:*

Gumbel$entropy(base = 2, ...)

*Arguments:*

base (integer(1))

Base of the entropy logarithm, default = 2 (Shannon entropy)

... Unused.

**Method** mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X [exp(xt)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X.

*Usage:*

Gumbel$mgf(t, ...)

*Arguments:*

t (integer(1))

t integer to evaluate function at.

... Unused.

**Method** cf(): The characteristic function is defined by

\[ cf_X(t) = E_X [exp(xti)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X. pracma::gammaz() is used in this function to allow complex inputs.

*Usage:*

Gumbel$cf(t, ...)

Arguments:
t (integer(1))
    t integer to evaluate function at.
... Unused.

Method \texttt{pgf}(): The probability generating function is defined by

$$pgf_X(z) = E_X[exp(z^x)]$$

where \(X\) is the distribution and \(E_X\) is the expectation of the distribution \(X\).

Usage:
Gumbel$pgf(z, ...)

Arguments:
z (integer(1))
    z integer to evaluate probability generating function at.
... Unused.

Method \texttt{clone}(): The objects of this class are cloneable with this method.

Usage:
Gumbel$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

References
Michael P. McLaughlin.

See Also
Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, 
ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, 
Frechet, Gamma, Gompertz, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, 
Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, 
Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, 
Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, 
Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, 
Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, 
NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, 
StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete
hazard  

Hazard Function

Description

See ExoticStatistics$ hazard.

Usage

hazard(object, ..., log = FALSE, simplify = TRUE, data = NULL)

Arguments

object  

(Distribution).

...  

(numeric())

Points to evaluate the probability density function of the distribution. Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

log  

logical(1)

If TRUE returns log-Hazard Default is FALSE.

simplify  

logical(1)

If TRUE (default) simplifies the pdf if possible to a numeric, otherwise returns a data.table:: data.table.

data  

array

Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

Value

Hazard function as a numeric, natural logarithm returned if log is TRUE.

huberize  

Huberize a Distribution

Description

S3 functionality to huberize an R6 distribution.

Usage

huberize(x, lower, upper)
**Arguments**

- $x$ distribution to huberize.
- `lower` lower limit for huberization.
- `upper` upper limit for huberization.

**See Also**

- HuberizedDistribution

---

**Description**

A wrapper for huberizing any probability distribution at given limits.

**Details**

The pdf and cdf of the distribution are required for this wrapper, if unavailable decorate with `FunctionImputation` first.

Huberizes a distribution at lower and upper limits, using the formula

$$
\begin{align*}
  f_H(x) &= F(x), \text{if } x \leq \text{lower} \\
  f_H(x) &= f(x), \text{if } \text{lower} < x < \text{upper} \\
  f_H(x) &= F(x), \text{if } x \geq \text{upper}
\end{align*}
$$

where $f_H$ is the pdf of the truncated distribution $H = \text{Huberize}(X, \text{lower}, \text{upper})$ and $f_X/F_X$ is the pdf/cdf of the original distribution.

**Super classes**

```r
distr6::Distribution -> distr6::DistributionWrapper -> HuberizedDistribution
```

**Methods**

**Public methods:**

- `HuberizedDistribution$new()`
- `HuberizedDistribution$setParameterValue()`
- `HuberizedDistribution$clone()`

**Method `new()`:** Creates a new instance of this R6 class.

**Usage:**

```
HuberizedDistribution$new(distribution, lower = NULL, upper = NULL)
```

**Arguments:**
distribution ([Distribution])
  Distribution to wrap.
lower (numeric(1))
  Lower limit to huberize the distribution at. If NULL then the lower bound of the Distribution is used.
upper (numeric(1))
  Upper limit to huberize the distribution at. If NULL then the upper bound of the Distribution is used.

Examples:
HuberizedDistribution$new(
  Binomial$new(prob = 0.5, size = 10),
  lower = 2, upper = 4
)

# alternate constructor
huberize(Binomial$new(), lower = 2, upper = 4)

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
HuberizedDistribution$setParameterValue(
  ...,
  lst = NULL,
  error = "warn",
  resolveConflicts = FALSE
)

Arguments:
... ANY
  Named arguments of parameters to set values for. See examples.
lst (list(1))
  Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.
error (character(1))
  If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
  If FALSE (default) throws error if conflicting parameterisations are provided, otherwise automatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
HuberizedDistribution$clone(deep = FALSE)

Arguments:
deep  Whether to make a deep clone.

See Also
Other wrappers: Convolution, DistributionWrapper, MixtureDistribution, ProductDistribution, TruncatedDistribution, VectorDistribution
Examples

```r
# Method `HuberizedDistribution$new`
# ------------------------------------------
HuberizedDistribution$new(
  Binomial$new(prob = 0.5, size = 10),
  lower = 2, upper = 4
)

# alternate constructor
huberize(Binomial$new(), lower = 2, upper = 4)
```

---

**Hypergeometric**

**Hypergeometric Distribution Class**

**Description**

Mathematical and statistical functions for the Hypergeometric distribution, which is commonly used to model the number of successes out of a population containing a known number of possible successes, for example the number of red balls from an urn or red, blue and yellow balls.

**Details**

The Hypergeometric distribution parameterised with population size, \( N \), number of possible successes, \( K \), and number of draws from the distribution, \( n \), is defined by the pmf,

\[
f(x) = \frac{C(K, x)C(N - K, n - x)}{C(N, n)}
\]

for \( N = \{0, 1, 2, \ldots\} \), \( n, K = \{0, 1, 2, \ldots, N\} \) and \( C(a, b) \) is the combination (or binomial coefficient) function.

**Value**

Returns an R6 object inheriting from class `SDistribution`.

**Distribution support**

The distribution is supported on \( \{\max(0, n + K - N), \ldots, \min(n, K)\} \).

**Default Parameterisation**

Hyper(size = 50, successes = 5, draws = 10)

**Omitted Methods**

N/A
Also known as
N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> Hypergeometric

Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.
packages  Packages required to be installed in order to construct the distribution.

Methods

Public methods:

• Hypergeometric$new()
• Hypergeometric$mean()
• Hypergeometric$mode()
• Hypergeometric$variance()
• Hypergeometric$skewness()
• Hypergeometric$kurtosis()
• Hypergeometric$setParameterValue()
• Hypergeometric$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Hypergeometric$new(
  size = NULL,
  successes = NULL,
  failures = NULL,
  draws = NULL,
  decorators = NULL
)

Arguments:

size (integer(1))  
  Population size. Defined on positive Naturals.
successes (integer(1))  
  Number of population successes. Defined on positive Naturals.
failures (integer(1))  
  Number of population failures. failures = size -successes. If given then successes is ignored. Defined on positive Naturals.
draws (integer(1))  
  Number of draws from the distribution, defined on the positive Naturals.
decorators (character())
Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

$$E_X(X) = \sum p_X(x) \cdot x$$

with an integration analogue for continuous distributions.

Usage:
Hypergeometric$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Hypergeometric$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula

$$\text{var}_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution $X$. If the distribution is multivariate the covariance matrix is returned.

Usage:
Hypergeometric$variance(...)

Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

$$sk_X = E_X\left[\frac{x - \mu}{\sigma}\right]^3$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution.

Usage:
Hypergeometric$skewness(...)

Arguments:
... Unused.
Method `kurtosis()`: The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X\left(\frac{x - \mu}{\sigma}\right)^4 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
Hypergeometric$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))
If TRUE (default) excess kurtosis returned.
... Unused.

Method `setParameterValue()`: Sets the value(s) of the given parameter(s).

Usage:
Hypergeometric$setParameterValue(
   ..., 
   lst = NULL, 
   error = "warn", 
   resolveConflicts = FALSE
)

Arguments:
... ANY
   Named arguments of parameters to set values for. See examples.
lst (list(1))
   Alternative argument for passing parameters. List names should be parameter names and
   list values are the new values to set.
error (character(1))
   If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
   If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
   tomatically resolves them by removing all conflicting parameters.

Method `clone()`: The objects of this class are cloneable with this method.

Usage:
Hypergeometric$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

References
See Also

Other discrete distributions: Bernoulli, Binomial, Categorical, Degenerate, DiscreteUniform, EmpiricalMV, Empirical, Geometric, Logarithmic, Multinomial, NegativeBinomial, WeightedDiscrete

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

---

**Infimum Accessor**

### Description

Returns the distribution infimum as the infimum of the support.

### Usage

```r
inf(object)
```

### Arguments

- **object** Distribution.

### Value

Infimum as a numeric.

### R6 Usage

```r
$inf
```

---

**InverseGamma**

### Description

Mathematical and statistical functions for the Inverse Gamma distribution, which is commonly used in Bayesian statistics as the posterior distribution from the unknown variance in a Normal distribution.
Details
The Inverse Gamma distribution parameterised with shape, \( \alpha \), and scale, \( \beta \), is defined by the pdf,

\[
f(x) = \frac{\beta^\alpha}{\Gamma(\alpha)} x^{-\alpha-1} \exp(-\beta/x)
\]

for \( \alpha, \beta > 0 \), where \( \Gamma \) is the gamma function.

Value
Returns an R6 object inheriting from class SDistribution.

Distribution support
The distribution is supported on the Positive Reals.

Default Parameterisation
InvGamma(shape = 1, scale = 1)

Omitted Methods
N/A

Also known as
N/A

Super classes
distr6::Distribution -> distr6::SDistribution -> InverseGamma

Public fields
name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.

Methods
Public methods:
- InverseGamma$new()
- InverseGamma$mean()
- InverseGamma$mode()
- InverseGamma$variance()
- InverseGamma$skewness()
- InverseGamma$kurtosis()
- InverseGamma$entropy()
Method new(): Creates a new instance of this R6 class.

Usage:
InverseGamma$new(shape = NULL, scale = NULL, decorators = NULL)

Arguments:
shape (numeric(1))
  Shape parameter, defined on the positive Reals.
scale (numeric(1))
  Scale parameter, defined on the positive Reals.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) * x \]

with an integration analogue for continuous distributions.

Usage:
InverseGamma$mean()

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
InverseGamma$mode(which = "all")

Arguments:
which (character(1) | numeric(1)
  Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula

\[ var_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

Usage:
InverseGamma$variance()

Arguments:
... Unused.
Method `skewness()`: The skewness of a distribution is defined by the third standardised moment,

\[ \text{sk}_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
`InverseGamma$skewness(...)`

Arguments:
... Unused.

Method `kurtosis()`: The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
`InverseGamma$kurtosis(excess = TRUE, ...)`

Arguments:
excess (logical(1))
  If TRUE (default) excess kurtosis returned.
... Unused.

Method `entropy()`: The entropy of a (discrete) distribution is defined by

\[ -\sum (f_X) \log(f_X) \]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
`InverseGamma$entropy(base = 2, ...)`

Arguments:
base (integer(1))
  Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method `mgf()`: The moment generating function is defined by

\[ mgf_X(t) = E_X[exp(tX)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
`InverseGamma$mgf(t, ...)`

Arguments:
InverseGamma

\[ t \ (\text{integer}(1)) \]
\[ t \text{ integer to evaluate function at.} \]
\[ \ldots \text{ Unused.} \]

**Method** `pgf()`: The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(z^t)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

**Usage:**

\[ \text{InverseGamma$pgf(z, \ldots)}} \]

**Arguments:**

\[ z \ (\text{integer}(1)) \]
\[ z \text{ integer to evaluate probability generating function at.} \]
\[ \ldots \text{ Unused.} \]

**Method** `clone()`: The objects of this class are cloneable with this method.

**Usage:**

\[ \text{InverseGamma$clone(deep = FALSE)}} \]

**Arguments:**

\[ \text{deep} \quad \text{Whether to make a deep clone.} \]

**References**


**See Also**

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete
### iqr

**Distribution Interquartile Range**

**Description**

Interquartile range of a distribution

**Usage**

iqr(object)

**Arguments**

- **object**
  - Distribution.

**Value**

Interquartile range of distribution as a numeric.

---

### Kernel

**Abstract Kernel Class**

**Description**

Abstract class that cannot be constructed directly.

**Value**

Returns error. Abstract classes cannot be constructed directly.

**Super class**

distr6::Distribution -> Kernel

**Public fields**

- **package**
  - Deprecated, use $packages instead.
- **packages**
  - Packages required to be installed in order to construct the distribution.
Methods

Public methods:

• `Kernel$new()`
• `Kernel$mode()`
• `Kernel$mean()`
• `Kernel$median()`
• `Kernel$pdfSquared2Norm()`
• `Kernel$cdfSquared2Norm()`
• `Kernel$skewness()`
• `Kernel$clone()`

Method `new()`: Creates a new instance of this R6 class.

Usage:
`Kernel$new(decorators = NULL, support = Interval$new(-1, 1))`

Arguments:

- `decorators` (character())
  Decorators to add to the distribution during construction.
- `support` [set6::Set]
  Support of the distribution.

Method `mode()`: Calculates the mode of the distribution.

Usage:
`Kernel$mode(which = "all")`

Arguments:

- `which` (character(1) | numeric(1))
  Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method `mean()`: Calculates the mean (expectation) of the distribution.

Usage:
`Kernel$mean(...)`

Arguments:

... Unused.

Method `median()`: Calculates the median of the distribution.

Usage:
`Kernel$median()`

Method `pdfSquared2Norm()`: The squared 2-norm of the pdf is defined by

\[
\int_a^b (f_X(u))^2 \, du
\]

where X is the Distribution, \( f_X \) is its pdf and \( a, b \) are the distribution support limits.
Usage:
Kernel$pdfSquared2Norm(x = 0, upper = Inf)

Arguments:
x (numeric(1))
  Amount to shift the result.
upper (numeric(1))
  Upper limit of the integral.

Method cdfSquared2Norm(): The squared 2-norm of the cdf is defined by

\[ \int_a^b (F_X(u))^2 \, du \]

where X is the Distribution, \( F_X \) is its pdf and \( a, b \) are the distribution support limits.

Usage:
Kernel$cdfSquared2Norm(x = 0, upper = Inf)

Arguments:
x (numeric(1))
  Amount to shift the result.
upper (numeric(1))
  Upper limit of the integral.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

\[ sk_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]

where \( E_X \) is the expectation of distribution X, \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
Kernel$skewness(...) 

Arguments:
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Kernel$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.
**kthmoment**  

**Kth Moment**

**Description**

Kth standardised or central moment of a distribution

**Usage**

`kthmoment(object, k, type = c("central", "standard", "raw"), ...)`

**Arguments**

- `object`: Distribution.
- `k`: the kth moment to calculate
- `type`: one of 'central', 'standard' or 'raw', abbreviations allowed
- `...`: Passed to $genExp.

**Value**

If univariate, the given k-moment as a numeric, otherwise NULL.

---

**kurtosis**  

**Distribution Kurtosis**

**Description**

Kurtosis of a distribution

**Usage**

`kurtosis(object, excess = TRUE, ...)`

**Arguments**

- `object`: Distribution.
- `excess`: logical, if TRUE (default) excess Kurtosis returned.
- `...`: Passed to $genExp.

**Value**

Kurtosis as a numeric.
kurtosisType

Type of Kurtosis Accessor - Deprecated

Description

Deprecated. Use $properties$kurtosis.

Usage

kurtosisType(object)

Arguments

object Distribution.

Value

If the distribution kurtosis is present in properties, returns one of "platykurtic"/"mesokurtic"/"leptokurtic", otherwise returns NULL.

Laplace

Laplace Distribution Class

Description

Mathematical and statistical functions for the Laplace distribution, which is commonly used in signal processing and finance.

Details

The Laplace distribution parameterised with mean, \( \mu \), and scale, \( \beta \), is defined by the pdf,

\[
 f(x) = \exp(-|x - \mu|/\beta)/(2\beta)
\]

for \( \mu \in \mathbb{R} \) and \( \beta > 0 \).

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on the Reals.

Default Parameterisation

Lap(mean = 0, scale = 1)
Laplace

Omitted Methods
N/A

Also known as
N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> Laplace

Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.
packages  Packages required to be installed in order to construct the distribution.

Methods

Public methods:

• Laplace$new()
• Laplace$mean()
• Laplace$mode()
• Laplace$variance()
• Laplace$skewness()
• Laplace$kurtosis()
• Laplace$entropy()
• Laplace$mgf()
• Laplace$cf()
• Laplace$pgf()
• Laplace$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Laplace$new(mean = NULL, scale = NULL, var = NULL, decorators = NULL)

Arguments:
mean (numeric(1))
  Mean of the distribution, defined on the Reals.
scale (numeric(1))
  Scale parameter, defined on the positive Reals.
var (numeric(1))
  Variance of the distribution, defined on the positive Reals. var = 2*scale^2. If var is provided then scale is ignored.
decorators (character())
  Decorators to add to the distribution during construction.

**Method** mean(): The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

$$E_X(X) = \sum p_X(x) \times x$$

with an integration analogue for continuous distributions.

*Usage:*

Laplace$mean(...)

*Arguments:*

... Unused.

**Method** mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

*Usage:*

Laplace$mode(which = "all")

*Arguments:*

which (character(1) | numeric(1))

Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

**Method** variance(): The variance of a distribution is defined by the formula

$$var_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution $X$. If the distribution is multivariate the covariance matrix is returned.

*Usage:*

Laplace$variance(...)

*Arguments:*

... Unused.

**Method** skewness(): The skewness of a distribution is defined by the third standardised moment,

$$sk_X = E_X\left[\frac{x - \mu}{\sigma}^3\right]$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution.

*Usage:*

Laplace$skewness(...)

*Arguments:*

... Unused.
Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is \( \text{Kurtosis} - 3 \).

Usage:
Laplace$kurtosis(excess = TRUE, \ldots)

Arguments:
excess (logical(1))
  If TRUE (default) excess kurtosis returned.
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by

\[ -\sum (f_X) \log(f_X) \]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
Laplace$entropy(base = 2, \ldots)

Arguments:
base (integer(1))
  Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X[exp(xt)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Laplace$mgf(t, \ldots)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Unused.

Method cf(): The characteristic function is defined by

\[ cf_X(t) = E_X[exp(xti)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Laplace$cf(t, \ldots)

Arguments:
Method \( \text{pgf}() \): The probability generating function is defined by

\[
\text{pgf}_X(z) = E_X[exp(z^X)]
\]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Laplace$\text{pgf}(z, ...)$

Arguments:
\( z \) (integer(1))
\( z \) integer to evaluate probability generating function at.

Method \( \text{clone}() \): The objects of this class are cloneable with this method.

Usage:
Laplace$\text{clone}(\text{deep} = \text{FALSE})$

Arguments:
depth Whether to make a deep clone.

References


See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete
length.VectorDistribution

Get Number of Distributions in Vector Distribution

Description

Gets the number of distributions in an object inheriting from VectorDistribution.

Usage

```r
## S3 method for class 'VectorDistribution'
length(x)
```

Arguments

- `x`  
  VectorDistribution

liesInSupport

Test if Data Lies in Distribution Support

Description

Tests if the given data lies in the support of the Distribution, either tests if all data lies in the support or any of it.

Usage

```r
liesInSupport(object, x, all = TRUE, bound = FALSE)
```

Arguments

- `object`  
  Distribution.
- `x`  
  vector of numerics to test.
- `all`  
  logical, see details.
- `bound`  
  logical, if FALSE (default) uses dmin/dmax otherwise inf/sup.

Value

Either a vector of logicals if all is FALSE otherwise returns TRUE if every element lies in the distribution support or FALSE otherwise.
liesInType

Test if Data Lies in Distribution Type

Description

Tests if the given data lies in the type of the Distribution, either tests if all data lies in the type or any of it.

Usage

liesInType(object, x, all = TRUE, bound = FALSE)

Arguments

<table>
<thead>
<tr>
<th>argument</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>object</td>
<td>Distribution.</td>
</tr>
<tr>
<td>x</td>
<td>vector of numerics to test.</td>
</tr>
<tr>
<td>all</td>
<td>logical, see details.</td>
</tr>
<tr>
<td>bound</td>
<td>logical, if FALSE (default) uses dmin/dmax otherwise inf/sup.</td>
</tr>
</tbody>
</table>

Value

Either a vector of logicals if all is FALSE otherwise returns TRUE if every element lies in the distribution type or FALSE otherwise.

lines.Distribution

Superimpose Distribution Functions Plots for a distr6 Object

Description

One of six plots can be selected to be superimposed in the plotting window, including: pdf, cdf, quantile, survival, hazard and cumulative hazard.

Usage

```r
## S3 method for class 'Distribution'
lines(x, fun, npoints = 3000, ...)
```

Arguments

<table>
<thead>
<tr>
<th>argument</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>distr6 object.</td>
</tr>
<tr>
<td>fun</td>
<td>vector of functions to plot, one or more of: &quot;pdf&quot;,&quot;cdf&quot;,&quot;quantile&quot;, &quot;survival&quot;, &quot;hazard&quot;, and &quot;cumhazard&quot;; partial matching available.</td>
</tr>
<tr>
<td>npoints</td>
<td>number of evaluation points.</td>
</tr>
<tr>
<td>...</td>
<td>graphical parameters.</td>
</tr>
</tbody>
</table>
Details

Unlike the \code{plot.Distribution} function, no internal checks are performed to ensure that the added plot makes sense in the context of the current plotting window. Therefore this function assumes that the current plot is of the same value support, see examples.

Author(s)

Chengyang Gao, Runlong Yu and Shuhan Liu

See Also

\code{plot.Distribution} for plotting a \code{distr6} object.

Examples

```r
plot(Normal$new(mean = 2), "pdf")
lines(Normal$new(mean = 3), "pdf", col = "red", lwd = 2)

## Not run:
# The code below gives examples of how not to use this function.
# Different value supports
plot(Binomial$new(), "cdf")
lines(Normal$new(), "cdf")

# Different functions
plot(Binomial$new(), "pdf")
lines(Binomial$new(), "cdf")

# Too many functions
plot(Binomial$new(), c("pdf", "cdf"))
lines(Binomial$new(), "cdf")

## End(Not run)
```

listDecorators

Lists Implemented Distribution Decorators

Description

Lists decorators that can decorate an R6 Distribution.

Usage

```r
listDecorators(simplify = TRUE)
```

Arguments

- `simplify` logical. If \code{TRUE} (default) returns results as characters, otherwise as R6 classes.
Value

Either a list of characters (if simplify is TRUE) or a list of DistributionDecorator classes.

See Also

DistributionDecorator

Examples

listDecorators()
listDecorators(FALSE)

listDistributions  Lists Implemented Distributions

Description

Lists distr6 distributions in a data.table or a character vector, can be filtered by traits, implemented package, and tags.

Usage

listDistributions(simplify = FALSE, filter = NULL)

Arguments

simplify  logical. If FALSE (default) returns distributions with traits as a data.table, otherwise returns distribution names as characters.

filter  list to filter distributions by. See examples.

Value

Either a list of characters (if simplify is TRUE) or a data.table of SDistributions and their traits.

See Also

SDistribution

Examples

listDistributions()

# Filter list
listDistributions(filter = list(VariateForm = "univariate")

# Filter is case-insensitive
listDistributions(filter = list(VaLuESupport = "discrete")

# Multiple filters
listDistributions(filter = list(VaLuESupport = "discrete", package = "extraDistr"))
listKernels

Lists Implemented Kernels

Description
Lists all implemented kernels in distr6.

Usage
listKernels(simplify = FALSE)

Arguments
simplify logical. If FALSE (default) returns kernels with support as a data.table, otherwise returns kernel names as characters.

Value
Either a list of characters (if simplify is TRUE) or a data.table of Kernels and their traits.

See Also
Kernel

Examples
listKernels()

listWrappers

Lists Implemented Distribution Wrappers

Description
Lists wrappers that can wrap an R6 Distribution.

Usage
listWrappers(simplify = TRUE)

Arguments
simplify logical. If TRUE (default) returns results as characters, otherwise as R6 classes.

Value
Either a list of characters (if simplify is TRUE) or a list of Wrapper classes.
Logarithmic

See Also

DistributionWrapper

Examples

listWrappers()
listWrappers(TRUE)

Logarithmic Distribution Class

Description

Mathematical and statistical functions for the Logarithmic distribution, which is commonly used to model consumer purchase habits in economics and is derived from the Maclaurin series expansion of $-\ln(1 - p)$.

Details

The Logarithmic distribution parameterised with a parameter, $\theta$, is defined by the pmf,

$$f(x) = -\frac{\theta^x}{x \log(1 - \theta)}$$

for $0 < \theta < 1$.

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on 1, 2, 3, . . . .

Default Parameterisation

Log(theta = 0.5)

Omitted Methods

N/A

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> Logarithmic
Logarithmic

Public fields

- name: Full name of distribution.
- short_name: Short name of distribution for printing.
- description: Brief description of the distribution.
- packages: Packages required to be installed in order to construct the distribution.

Methods

**Public methods:**

- `Logarithmic$new()`
- `Logarithmic$mean()`
- `Logarithmic$mode()`
- `Logarithmic$variance()`
- `Logarithmic$skewness()`
- `Logarithmic$kurtosis()`
- `Logarithmic$mgf()`
- `Logarithmic$cf()`
- `Logarithmic$pgf()`
- `Logarithmic$clone()`

**Method new():** Creates a new instance of this R6 class.

**Usage:**

`Logarithmic$new(theta = NULL, decorators = NULL)`

**Arguments:**

- `theta`: numeric(1)
  - Theta parameter defined as a probability between 0 and 1.
- `decorators`: character()
  - Decorators to add to the distribution during construction.

**Method mean():** The arithmetic mean of a (discrete) probability distribution \( X \) is the expectation

\[
E_X(X) = \sum p_X(x) \times x
\]

with an integration analogue for continuous distributions.

**Usage:**

`Logarithmic$mean(...)`

**Arguments:**

- `...`: Unused.

**Method mode():** The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

**Usage:**

`Logarithmic$mode(which = "all")`
Arguments:
which (character(1) | numeric(1))
Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula
\[ \text{var}_X = E[X^2] - E[X]^2 \]
where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
Logarithmic$variance(...)
Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,
\[ \text{sk}_X = E_X \left( \frac{x - \mu}{\sigma} \right)^3 \]
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
Logarithmic$skewness(...)
Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,
\[ k_X = E_X \left( \frac{x - \mu}{\sigma} \right)^4 \]
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
Logarithmic$kurtosis(excess = TRUE, ...)
Arguments:
excess (logical(1))
If TRUE (default) excess kurtosis returned.
... Unused.

Method mgf(): The moment generating function is defined by
\[ mgf_X(t) = E_X[exp(xt)] \]
where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Logarithmic

Logarithmic$mgf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Unused.

Method cf(): The characteristic function is defined by

\[ cf_X(t) = E_X[exp(xt)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X.

Usage:
Logarithmic$cf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Unused.

Method pgf(): The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(xz)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X.

Usage:
Logarithmic$pgf(z, ...)

Arguments:
z (integer(1))
  z integer to evaluate probability generating function at.
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Logarithmic$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

References

Logistic Distribution Class

Description
Mathematical and statistical functions for the Logistic distribution, which is commonly used in logistic regression and feedforward neural networks.

Details
The Logistic distribution parameterised with mean, $\mu$, and scale, $s$, is defined by the pdf,

$$f(x) = \frac{\exp(-(x - \mu)/s)}{(s(1 + \exp(-(x - \mu)/s))^2)}$$

for $\mu \in \mathbb{R}$ and $s > 0$.

Value
Returns an R6 object inheriting from class SDistribution.

Distribution support
The distribution is supported on the Reals.

Default Parameterisation
Logis(mean = 0, scale = 1)

Omitted Methods
N/A

Also known as
N/A

Super classes
distr6::Distribution -> distr6::SDistribution -> Logistic
Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.
packages  Packages required to be installed in order to construct the distribution.

Methods

Methods

Public methods:

• Logistic$new()
• Logistic$mean()
• Logistic$mode()
• Logistic$variance()
• Logistic$skewness()
• Logistic$kurtosis()
• Logistic$entropy()
• Logistic$mgf()
• Logistic$cf()
• Logistic$pgf()
• Logistic$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Logistic$new(mean = NULL, scale = NULL, sd = NULL, decorators = NULL)

Arguments:
mean (numeric(1))
  Mean of the distribution, defined on the Reals.
scale (numeric(1))
  Scale parameter, defined on the positive Reals.
sd (numeric(1))
  Standard deviation of the distribution as an alternate scale parameter, sd = scale*pi/sqrt(3).
  If given then scale is ignored.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) * x \]

with an integration analogue for continuous distributions.

Usage:
Logistic$mean(...)

Arguments:
Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Logistic$mode(which = "all")

Arguments:
which (character(1) | numeric(1))

Ignored if distribution is unimodal. Otherwise “all” returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula
\[ \text{var}_X = E[X^2] - E[X]^2 \]
where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
Logistic$variance(...)

Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,
\[ s_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
Logistic$skewness(...)

Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,
\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
Logistic$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))

If TRUE (default) excess kurtosis returned.
... Unused.
Method entropy(): The entropy of a (discrete) distribution is defined by

$$-\sum (f_X) \log(f_X)$$

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
Logistic$entropy(base = 2, ...)

Arguments:
base (integer(1))
  Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method mgf(): The moment generating function is defined by

$$mgf_X(t) = E_X[exp(xt)]$$

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Logistic$mgf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Unused.

Method cf(): The characteristic function is defined by

$$cf_X(t) = E_X[exp(xti)]$$

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Logistic$cf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Unused.

Method pgf(): The probability generating function is defined by

$$pgf_X(z) = E_X[exp(zx)]$$

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Logistic$pgf(z, ...)

Arguments:
z (integer(1))
  z integer to evaluate probability generating function at.
Mathematical and statistical functions for the LogisticKernel kernel defined by the pdf,

\[ f(x) = \left( e^{x} + 2 + e^{-x} \right)^{-1} \]

over the support \( x \in \mathbb{R} \).

**Super classes**

`distr6::Distribution -> distr6::Kernel -> LogisticKernel`

**Public fields**

- name Full name of distribution.
- short_name Short name of distribution for printing.
- description Brief description of the distribution.
Methods

Public methods:
- LogisticKernel$new()
- LogisticKernel$pdfSquared2Norm()
- LogisticKernel$cdfSquared2Norm()
- LogisticKernel$variance()
- LogisticKernel$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
LogisticKernel$new(decorators = NULL)

Arguments:
- decorators (character()): Decorators to add to the distribution during construction.

Method pdfSquared2Norm(): The squared 2-norm of the pdf is defined by

\[ \int_{a}^{b} (f_X(u))^2 \, du \]

where X is the Distribution, \( f_X \) is its pdf and a, b are the distribution support limits.

Usage:
LogisticKernel$pdfSquared2Norm(x = 0, upper = Inf)

Arguments:
- x (numeric(1)): Amount to shift the result.
- upper (numeric(1)): Upper limit of the integral.

Method cdfSquared2Norm(): The squared 2-norm of the cdf is defined by

\[ \int_{a}^{b} (F_X(u))^2 \, du \]

where X is the Distribution, \( F_X \) is its pdf and a, b are the distribution support limits.

Usage:
LogisticKernel$cdfSquared2Norm(x = 0, upper = 0)

Arguments:
- x (numeric(1)): Amount to shift the result.
- upper (numeric(1)): Upper limit of the integral.
Method variance(): The variance of a distribution is defined by the formula

$$var_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution $X$. If the distribution is multivariate the covariance matrix is returned.

Usage:
LogisticKernel$variance(...)

Arguments:
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
LogisticKernel$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

See Also

Other kernels: Cosine, Epanechnikov, NormalKernel, Quartic, Sigmoid, Silverman, TriangularKernel, Tricube, Triweight, UniformKernel

Loglogistic

Log-Logistic Distribution Class

Description

Mathematical and statistical functions for the Log-Logistic distribution, which is commonly used in survival analysis for its non-monotonic hazard as well as in economics.

Details

The Log-Logistic distribution parameterised with shape, $\beta$, and scale, $\alpha$ is defined by the pdf,

$$f(x) = (\beta/\alpha)(x/\alpha)^{\beta-1}(1 + (x/\alpha)^{\beta})^{-2}$$

for $\alpha, \beta > 0$.

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on the non-negative Reals.
Default Parameterisation

\[ LL\text{log}(\text{scale} = 1, \text{shape} = 1) \]

Omitted Methods

N/A

Also known as

Also known as the Fisk distribution.

Super classes

\[ \text{distr6::Distribution} \rightarrow \text{distr6::SDistribution} \rightarrow \text{Loglogistic} \]

Public fields

- name: Full name of distribution.
- short_name: Short name of distribution for printing.
- description: Brief description of the distribution.
- packages: Packages required to be installed in order to construct the distribution.

Methods

Public methods:

- Loglogistic$new()
- Loglogistic$mean()
- Loglogistic$mode()
- Loglogistic$median()
- Loglogistic$variance()
- Loglogistic$skewness()
- Loglogistic$kurtosis()
- Loglogistic$pgf()
- Loglogistic$clone()

Method new(): Creates a new instance of this R6 class.

Usage:

\[ \text{Loglogistic}\$\text{new}(\text{scale} = \text{NULL}, \text{shape} = \text{NULL}, \text{rate} = \text{NULL}, \text{decorators} = \text{NULL}) \]

Arguments:

- scale (numeric(1))
  - Scale parameter, defined on the positive Reals.
- shape (numeric(1))
  - Shape parameter, defined on the positive Reals.
- rate (numeric(1))
  - Alternate scale parameter, \( \text{rate} = 1/\text{scale} \). If given then scale is ignored.
decorators (character())

Decorators to add to the distribution during construction.

**Method** *mean()*: The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) * x \]

with an integration analogue for continuous distributions.

*Usage:*

Loglogistic$mean(…)

*Arguments:*

... Unused.

**Method** *mode()*: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

*Usage:*

Loglogistic$mode(which = "all")

*Arguments:*

which (character(1) | numeric(1))

Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

**Method** *median()*: Returns the median of the distribution. If an analytical expression is available returns distribution median, otherwise if symmetric returns self$mean, otherwise returns self$quantile(0.5).

*Usage:*

Loglogistic$median()

**Method** *variance()*: The variance of a distribution is defined by the formula

\[ var_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

*Usage:*

Loglogistic$variance(…)

*Arguments:*

... Unused.

**Method** *skewness()*: The skewness of a distribution is defined by the third standardised moment,

\[ sk_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]

where \( E_X \) is the expectation of distribution X, \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

*Usage:*

...
Loglogistic

Loglogistic$skewness(...)  
Arguments:  
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left( \frac{x - \mu}{\sigma} \right)^4 \]

where \( E_X \) is the expectation of distribution X, \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:  
Loglogistic$kurtosis(excess = TRUE, ...)

Arguments:  
excess (logical(1))  
If TRUE (default) excess kurtosis returned.  
... Unused.

Method pgf(): The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(z^x)] \]

where X is the distribution and \( E_X \) is the expectation of the distribution X.

Usage:  
Loglogistic$pgf(z, ...)

Arguments:  
z (integer(1))  
z integer to evaluate probability generating function at.  
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:  
Loglogistic$clone(deep = FALSE)

Arguments:  
deep Whether to make a deep clone.

References

Lognormal

See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

---

Lognormal

Log-Normal Distribution Class

Description

Mathematical and statistical functions for the Log-Normal distribution, which is commonly used to model many natural phenomena as a result of growth driven by small percentage changes.

Details

The Log-Normal distribution parameterised with logmean, \( \mu \), and logvar, \( \sigma \), is defined by the pdf,

\[
exp\left(-\frac{(log(x) - \mu)^2}{2\sigma^2}\right)/(x\sigma\sqrt{2\pi})
\]

for \( \mu \in \mathbb{R} \) and \( \sigma > 0 \).

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on the Positive Reals.

Default Parameterisation

Lnorm(meanlog = 0, varlog = 1)

Omitted Methods

N/A

Also known as

Also known as the Log-Gaussian distribution.
Lognormal

Super classes

\[ \text{distr6::Distribution} \rightarrow \text{distr6::SDistribution} \rightarrow \text{Lognormal} \]

Public fields

- name: Full name of distribution.
- short_name: Short name of distribution for printing.
- description: Brief description of the distribution.
- packages: Packages required to be installed in order to construct the distribution.

Methods

**Public methods:**

- `Lognormal$new()`
- `Lognormal$mean()`
- `Lognormal$mode()`
- `Lognormal$median()`
- `Lognormal$variance()`
- `Lognormal$skewness()`
- `Lognormal$kurtosis()`
- `Lognormal$entropy()`
- `Lognormal$mgf()`
- `Lognormal$pgf()`
- `Lognormal$clone()`

**Method new():** Creates a new instance of this R6 class.

**Usage:**

```r
Lognormal$new(
  meanlog = NULL,
  varlog = NULL,
  sdlog = NULL,
  preclog = NULL,
  mean = NULL,
  var = NULL,
  sd = NULL,
  prec = NULL,
  decorators = NULL
)
```

**Arguments:**

- `meanlog` (numeric(1))
  Mean of the distribution on the log scale, defined on the Reals.
- `varlog` (numeric(1))
  Variance of the distribution on the log scale, defined on the positive Reals.
\texttt{sdlog (numeric(1))}  
Standard deviation of the distribution on the log scale, defined on the positive Reals.  
\[ sdlog = varlog^2 \]

. If \texttt{preclog} missing and \texttt{sdlog} given then all other parameters except \texttt{meanlog} are ignored. 
\texttt{preclog (numeric(1))}  
Precision of the distribution on the log scale, defined on the positive Reals.  
\[ preclog = 1/varlog \]

. If given then all other parameters except \texttt{meanlog} are ignored. 
\texttt{mean (numeric(1))}  
Mean of the distribution on the natural scale, defined on the positive Reals. 
\texttt{var (numeric(1))}  
Variance of the distribution on the natural scale, defined on the positive Reals.  
\[ var = (exp(var) - 1)) * exp(2 * meanlog + varlog) \]
\texttt{sd (numeric(1))}  
Standard deviation of the distribution on the natural scale, defined on the positive Reals.  
\[ sd = var^2 \]

. If \texttt{prec} missing and \texttt{sd} given then all other parameters except \texttt{mean} are ignored. 
\texttt{prec (numeric(1))}  
Precision of the distribution on the natural scale, defined on the Reals.  
\[ prec = 1/var \]

. If given then all other parameters except \texttt{mean} are ignored. 
\texttt{decorators (character())}  
Decorators to add to the distribution during construction. 

\textit{Examples:} 
\texttt{Lognormal$new(var = 2, mean = 1) }  
\texttt{Lognormal$new(meanlog = 2, preclog = 5) }  

\textbf{Method} \texttt{mean():} The arithmetic mean of a (discrete) probability distribution X is the expectation  
\[ E_X(X) = \sum p_X(x) * x \]
with an integration analogue for continuous distributions. 

\textit{Usage:} 
\texttt{Lognormal$mean(...) }  
\textit{Arguments:}  
\texttt{...} Unused. 

\textbf{Method} \texttt{mode():} The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).
Lognormal

Usage:
Lognormal$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
   Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies
   which mode to return.
... Unused.

Method median(): Returns the median of the distribution. If an analytical expression is avail-
   able returns distribution median, otherwise if symmetric returns self$mean, otherwise returns
   self$quantile(0.5).
Usage:
Lognormal$median()

Method variance(): The variance of a distribution is defined by the formula
\[ \text{var}_X = E[X^2] - E[X]^2 \]
where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance
matrix is returned.
Usage:
Lognormal$variance(...)
Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised mo-
   ment,
\[ sk_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the
standard deviation of the distribution.
Usage:
Lognormal$skewness(...)
Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised mo-
   ment,
\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the
standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.
Usage:
Lognormal$kurtosis(excess = TRUE, ...)
Arguments:
excess (logical(1))
    If TRUE (default) excess kurtosis returned.
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by

\[- \sum (f_X) \log(f_X)\]

where $f_X$ is the pdf of distribution $X$, with an integration analogue for continuous distributions.

Usage:
Lognormal$entropy(base = 2, ...)

Arguments:
base (integer(1))
    Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method mgf(): The moment generating function is defined by

\[mgf_X(t) = E_X[exp(xt)]\]

where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$.

Usage:
Lognormal$mgf(t, ...)

Arguments:
t (integer(1))
    t integer to evaluate function at.
... Unused.

Method pgf(): The probability generating function is defined by

\[pgf_X(z) = E_X[exp(z^x)]\]

where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$.

Usage:
Lognormal$pgf(z, ...)

Arguments:
z (integer(1))
    z integer to evaluate probability generating function at.
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Lognormal$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.
References


See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

Examples

```r
## ------------------------------------------------
## Method `Lognormal$new`
## ------------------------------------------------

Lognormal$new(var = 2, mean = 1)
Lognormal$new(meanlog = 2, preclog = 5)
```

---

makeUniqueDistributions

*De-Duplicate Distribution Names*

Description

Helper function to lapply over the given distribution list, and make the short_names unique.

Usage

```
makeUniqueDistributions(distlist)
```

Arguments

- `distlist`: list of Distributions.

Details

The short_names are made unique by suffixing each with a consecutive number so that the names are no longer duplicated.
Value

The list of inputted distributions except with the short_names manipulated as necessary to make them unique.

Examples

makeUniqueDistributions(list(Binomial$new(), Binomial$new()))

mean.Distribution

Description

Arithmetic mean for the probability distribution.

Usage

## S3 method for class 'Distribution'
mean(x, ...)

Arguments

x Distribution.

... Passed to $genExp.

Value

Mean as a numeric.

median.Distribution

Description

Median of a distribution assuming quantile is provided.

Usage

## S3 method for class 'Distribution'
median(x, na.rm = NULL, ...)

Arguments

x Distribution.

na.rm ignored, added for consistency with S3 generic.

... ignored, added for consistency with S3 generic.
### merge.ParameterSet

**Description**

Combine ParameterSets

**Usage**

```r
## S3 method for class 'ParameterSet'
merge(x, y, ...)
```

**Arguments**

- `x`: ParameterSet
- `y`: ParameterSet
- `...`: ParameterSets

**Value**

An R6 object of class ParameterSet.

---

### mgf

**Description**

Moment generating function of a distribution

**Usage**

```r
mgf(object, t, ...)
```

**Arguments**

- `object`: Distribution.
- `t`: integer to evaluate moment generating function at.
- `...`: Passed to $genExp.

**Value**

Moment generating function evaluated at `t` as a numeric.
Description

Wrapper used to construct a mixture of two or more distributions.

Details

A mixture distribution is defined by

\[ F_P(x) = w_1 F_{X_1}(x) \times \ldots \times w_n F_{X_N}(x) \]

#nolint where \( F_P \) is the cdf of the mixture distribution, \( X_1, \ldots, X_N \) are independent distributions, and \( w_1, \ldots, w_N \) are weights for the mixture.

Super classes

distr6::Distribution -> distr6::DistributionWrapper -> distr6::VectorDistribution -> MixtureDistribution

Methods

Public methods:

- MixtureDistribution$new()
- MixtureDistribution$strprint()
- MixtureDistribution$pdf()
- MixtureDistribution$cdf()
- MixtureDistribution$quantile()
- MixtureDistribution$rand()
- MixtureDistribution$clone()

Method new(): Creates a new instance of this R6 class.

Usage:

MixtureDistribution$new(
    distlist = NULL,
    weights = "uniform",
    distribution = NULL,
    params = NULL,
    shared_params = NULL,
    name = NULL,
    short_name = NULL,
    decorators = NULL,
    vecdist = NULL,
    ids = NULL
)
Arguments:
distlist (list())
  List of Distributions.
weights (character(1)|numeric())
  Weights to use in the resulting mixture. If all distributions are weighted equally then
  "uniform" provides a much faster implementation, otherwise a vector of length equal to
  the number of wrapped distributions, this is automatically scaled internally.
distribution (character(1))
  Should be supplied with params and optionally shared_params as an alternative to distlist.
  Much faster implementation when only one class of distribution is being wrapped. distribution
  is the full name of one of the distributions in listDistributions(), or "Distribution"
  if constructing custom distributions. See examples in VectorDistribution.
params (list()|data.frame())
  Parameters in the individual distributions for use with distribution. Can be supplied as
  a list, where each element is the list of parameters to set in the distribution, or as an object
  coercable to data.frame, where each column is a parameter and each row is a distribution.
  See examples in VectorDistribution.
shared_params (list())
  If any parameters are shared when using the distribution constructor, this provides a
  much faster implementation to list and query them together. See examples in VectorDistribution.
name (character(1))
  Optional name of wrapped distribution.
short_name (character(1))
  Optional short name/ID of wrapped distribution.
decorators (character())
  Decorators to add to the distribution during construction.
vectvecdist VectorDistribution
  Alternative constructor to directly create this object from an object inheriting from Vec-
torDistribution.
ids (character())
  Optional ids for wrapped distributions in vector, should be unique and of same length as the
  number of distributions.

Examples:
MixtureDistribution$new(list(Binomial$new(prob = 0.5, size = 10), Binomial$new()),
  weights = c(0.2, 0.8)
)

Method strprint(): Printable string representation of the MixtureDistribution. Primarily
used internally.
Usage:
MixtureDistribution$strprint(n = 10)
Arguments:
  n (integer(1))
    Number of distributions to include when printing.
**Method** pdf(): Probability density function of the mixture distribution. Computed by

\[
f_M(x) = \sum_i (f_i(x) * w_i)
\]

where \(w_i\) is the vector of weights and \(f_i\) are the pdfs of the wrapped distributions.

Note that as this class inherits from `VectorDistribution`, it is possible to evaluate the distributions at different points, but that this is not the usual use-case for mixture distributions.

**Usage:**

```r
MixtureDistribution$pdf(..., log = FALSE, simplify = TRUE, data = NULL)
```

**Arguments:**

- `... (numeric())`
  Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

- `log (logical(1))`
  If TRUE returns the logarithm of the probabilities. Default is FALSE.

- `simplify logical(1)`
  If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.

- `data array`
  Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

**Examples:**

```r
m <- MixtureDistribution$new(list(Binomial$new(prob = 0.5, size = 10), Binomial$new()), weights = c(0.2, 0.8))
m$pdf(1:5)
m$pdf(1)
# also possible but unlikely to be used
m$pdf(1, 2)
```

**Method** cdf(): Cumulative distribution function of the mixture distribution. Computed by

\[
F_M(x) = \sum_i (F_i(x) * w_i)
\]

where \(w_i\) is the vector of weights and \(F_i\) are the cdfs of the wrapped distributions.

**Usage:**

```r
MixtureDistribution$cdf(
  ..., lower.tail = TRUE,
  log.p = FALSE,
  simplify = TRUE,
  data = NULL
)
```
Arguments:

... (numeric())

Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples. @examples

m <- MixtureDistribution$new(list(Binomial$new(prob = 0.5, size = 10), Binomial$new()), weights = c(0.2, 0.8)) m$cdf(1:5)

lower.tail (logical(1))

If TRUE (default), probabilities are $X \leq x$, otherwise, $P(X > x)$.

log.p (logical(1))

If TRUE returns the logarithm of the probabilities. Default is FALSE.

simplify logical(1)

If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.

data array

Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

Method quantile(): The quantile function is not implemented for mixture distributions.

Usage:

MixtureDistribution$quantile(

...,

lower.tail = TRUE,

log.p = FALSE,

simplify = TRUE,

data = NULL
)

Arguments:

... (numeric())

Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

lower.tail (logical(1))

If TRUE (default), probabilities are $X \leq x$, otherwise, $P(X > x)$.

log.p (logical(1))

If TRUE returns the logarithm of the probabilities. Default is FALSE.

simplify logical(1)

If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.

data array

Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

Method rand(): Simulation function for mixture distributions. Samples are drawn from a mixture by first sampling Multinomial(probs = weights, size = n), then sampling each distribution according to the samples from the Multinomial, and finally randomly permuting these draws.
Usage:
MixtureDistribution$rand(n, simplify = TRUE)

Arguments:
n (numeric(1))
   Number of points to simulate from the distribution. If length greater than 1, then n <- length(n),
simplify logical(1)
   If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.

Examples:
m <- MixtureDistribution$new(distribution = "Normal",
params = data.table::data.table(mean = 1:2), shared_params = list(sd = 1))
m$rand(5)

Method clone(): The objects of this class are cloneable with this method.

Usage:
MixtureDistribution$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

See Also
Other wrappers: Convolution, DistributionWrapper, HuberizedDistribution, ProductDistribution, TruncatedDistribution, VectorDistribution

Examples

```r
## ----------------------------------
## Method 'MixtureDistribution$new'
## ----------------------------------
MixtureDistribution$new(list(Binomial$new(prob = 0.5, size = 10), Binomial$new()),
weights = c(0.2, 0.8))

## ----------------------------------
## Method 'MixtureDistribution$pdf'
## ----------------------------------
m <- MixtureDistribution$new(list(Binomial$new(prob = 0.5, size = 10), Binomial$new()),
weights = c(0.2, 0.8))
m$pdf(1:5)
m$pdf(1)
# also possible but unlikely to be used
m$pdf(1, 2)

## ----------------------------------
## Method 'MixtureDistribution$rand'
## ----------------------------------
```
mixturiseVector

m <- MixtureDistribution$new(distribution = "Normal",
params = data.table::data.table(mean = 1:2), shared_params = list(sd = 1))
m$rand(5)

mixturiseVector Create Mixture Distribution From Multiple Vectors

Description
Given m vector distributions of length N, creates a single vector distribution consisting of n mixture distributions mixing the m vectors.

Usage
mixturiseVector(vecdists, weights = "uniform")

Arguments
vecdists (list())
List of VectorDistributions, should be of same length and with the non-'distlist' constructor with the same distribution.

weights (character(1)|numeric())
Weights passed to MixtureDistribution. Default uniform weighting.

Details
Let v1 = (D11, D12, ..., D1N) and v2 = (D21, D22, ..., D2N) then the mixturiseVector function creates the vector distribution v3 = (D31, D32, ..., D3N) where D3N = m(D1N, D2N, wN) where m is a mixture distribution with weights wN.

Examples
## Not run:
v1 <- VectorDistribution$new(distribution = "Binomial", params = data.frame(size = 1:2))
v2 <- VectorDistribution$new(distribution = "Binomial", params = data.frame(size = 3:4))
mv1 <- mixturiseVector(list(v1, v2))

# equivalently
mv2 <- VectorDistribution$new(list(  
  MixtureDistribution$new(distribution = "Binomial", params = data.frame(size = c(1, 3))),  
  MixtureDistribution$new(distribution = "Binomial", params = data.frame(size = c(2, 4)))  
))
mv1$pdf(1:5)
mv2$pdf(1:5)
## End(Not run)
mode

Mode of a Distribution

Description
A numeric search for the mode(s) of a distribution.

Usage
mode(object, which = "all")

Arguments
object Distribution.
which which mode of the distribution should be returned, default is all.

Details
If the distribution has multiple modes, all are returned by default. Otherwise the index of the mode to return can be given or "all" if all should be returned.

If an analytic expression isn’t available, returns error. To impute a numerical expression, use the CoreStatistics decorator.

Value
The estimated mode as a numeric, either all modes (if multiple) or the ordered mode given in which.

See Also
CoreStatistics and decorate.

Multinomial

Multinomial Distribution Class

Description
Mathematical and statistical functions for the Multinomial distribution, which is commonly used to extend the binomial distribution to multiple variables, for example to model the rolls of multiple dice multiple times.

Details
The Multinomial distribution parameterised with number of trials, \( n \), and probabilities of success, \( p_1, ..., p_k \), is defined by the pmf,

\[
  f(x_1, x_2, \ldots, x_k) = \frac{n!}{x_1! \cdot x_2! \cdot \ldots \cdot x_k!} \cdot p_1^{x_1} \cdot p_2^{x_2} \cdot \ldots \cdot p_k^{x_k}
\]

for \( p_i, i = 1, \ldots, k; \sum p_i = 1 \) and \( n = 1, 2, \ldots \)
**Multinomial**

**Value**

Returns an R6 object inheriting from class `SDistribution`.

**Distribution support**

The distribution is supported on $\sum x_i = N$.

**Default Parameterisation**

Multinom(size = 10, probs = c(0.5, 0.5))

**Omitted Methods**

CDF and quantile are omitted as no closed form analytic expression could be found, decorate with `FunctionImputation` for a numerical imputation.

**Also known as**

N/A

**Super classes**

distr6::Distribution -> distr6::SDistribution -> Multinomial

**Public fields**

name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.

**Methods**

**Public methods:**

- Multinomial$new()
- Multinomial$mean()
- Multinomial$variance()
- Multinomial$skewness()
- Multinomial$kurtosis()
- Multinomial$entropy()
- Multinomial$mgf()
- Multinomial$cf()
- Multinomial$pgf()
- Multinomial$setParameterValue()
- Multinomial$clone()

**Method new():** Creates a new instance of this R6 class.
Usage:
Multinomial$new(size = NULL, probs = NULL, decorators = NULL)

Arguments:
size (integer(1))
  Number of trials, defined on the positive Naturals.
probs (numeric())
  Vector of probabilities. Automatically normalised by probs = probs/sum(probs).
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

$$E_X(X) = \sum p_X(x) \cdot x$$

with an integration analogue for continuous distributions.

Usage:
Multinomial$mean(...)  
Arguments:
... Unused.

Method variance(): The variance of a distribution is defined by the formula

$$\text{var}_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

Usage:
Multinomial$variance(...)  
Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

$$sk_X = E_X\left[\frac{x - \mu}{\sigma}\right]^3$$

where $E_X$ is the expectation of distribution X, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution.

Usage:
Multinomial$skewness(...)  
Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

$$k_X = E_X\left[\frac{x - \mu}{\sigma}\right]^4$$

where $E_X$ is the expectation of distribution X, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.
Usage:
Multinomial$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))
    If TRUE (default) excess kurtosis returned.
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by
$$-\sum (f_X) log(f_X)$$
where $f_X$ is the pdf of distribution $X$, with an integration analogue for continuous distributions.

Usage:
Multinomial$entropy(base = 2, ...)

Arguments:
base (integer(1))
    Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method mgf(): The moment generating function is defined by
$$mgf_X(t) = E_X[exp(xt)]$$
where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$.

Usage:
Multinomial$mgf(t, ...)

Arguments:
t (integer(1))
    $t$ integer to evaluate function at.
... Unused.

Method cf(): The characteristic function is defined by
$$cf_X(t) = E_X[exp(xti)]$$
where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$.

Usage:
Multinomial$cf(t, ...)

Arguments:
t (integer(1))
    $t$ integer to evaluate function at.
... Unused.

Method pgf(): The probability generating function is defined by
$$pgf_X(z) = E_X[exp(z^x)]$$
where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$. 
Usage:
Multinomial$pgf(z, ...)

Arguments:
z (integer(1))
  z integer to evaluate probability generating function at.
...
  Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
Multinomial$setParameterValue(
  ..., 
  lst = NULL,
  error = "warn",
  resolveConflicts = FALSE
)

Arguments:
  ...
  ANY
  Named arguments of parameters to set values for. See examples.
  lst (list(1))
  Alternative argument for passing parameters. List names should be parameter names and
  list values are the new values to set.
  error (character(1))
  If "warn" then returns a warning on error, otherwise breaks if "stop".
  resolveConflicts (logical(1))
  If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
  tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Multinomial$clone(deep = FALSE)

Arguments:
  deep
  Whether to make a deep clone.

References

Michael P. McLaughlin.

See Also

Other discrete distributions: Bernoulli, Binomial, Categorical, Degenerate, DiscreteUniform,
EmpiricalMV, Empirical, Geometric, Hypergeometric, Logarithmic, NegativeBinomial, WeightedDiscrete
Other multivariate distributions: Dirichlet, EmpiricalMV, MultivariateNormal
Description

Mathematical and statistical functions for the Multivariate Normal distribution, which is commonly used to generalise the Normal distribution to higher dimensions, and is commonly associated with Gaussian Processes.

Details

The Multivariate Normal distribution parameterised with mean, $\mu$, and covariance matrix, $\Sigma$, is defined by the pdf,

$$f(x_1, \ldots, x_k) = (2 \pi)^{-k/2} \det(\Sigma)^{-1/2} \exp\left(-\frac{1}{2}(x - \mu)^T \Sigma^{-1} (x - \mu)\right)$$

for $\mu \in \mathbb{R}^k$ and $\Sigma \in \mathbb{R}^{k \times k}$.

Sampling is performed via the Cholesky decomposition using `chol`.

Number of variables cannot be changed after construction.

Value

Returns an R6 object inheriting from class `SDistribution`.

Distribution support

The distribution is supported on the Reals and only when the covariance matrix is positive-definite.

Default Parameterisation

`MultiNorm(mean = rep(0, 2), cov = c(1, 0, 0, 1))`

Omitted Methods

`cdf` and `quantile` are omitted as no closed form analytic expression could be found, decorate with `FunctionImputation` for a numerical imputation.

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> MultivariateNormal
Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.

Methods

Public methods:

• MultivariateNormal$new()
• MultivariateNormal$mean()
• MultivariateNormal$mode()
• MultivariateNormal$variance()
• MultivariateNormal$entropy()
• MultivariateNormal$mgf()
• MultivariateNormal$cf()
• MultivariateNormal$pgf()
• MultivariateNormal$getParameterValue()
• MultivariateNormal$setParameterValue()
• MultivariateNormal$clone()

Method new(): Creates a new instance of this R6 class. Number of variables cannot be changed after construction.

Usage:

MultivariateNormal$new(
  mean = rep(0, 2),
  cov = c(1, 0, 0, 1),
  prec = NULL,
  decorators = NULL
)

Arguments:

mean (numeric())
  Vector of means, defined on the Reals.
cov (matrix()|vector())
  Covariance of the distribution, either given as a matrix or vector coerced to a matrix via matrix(cov,nrow = K,byrow = FALSE). Must be semi-definite.
prec (matrix()|vector())
  Precision of the distribution, inverse of the covariance matrix. If supplied then cov is ignored. Given as a matrix or vector coerced to a matrix via matrix(cov,nrow = K,byrow = FALSE). Must be semi-definite.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

$$E_X(X) = \sum p_X(x) * x$$

with an integration analogue for continuous distributions.
Usage:
MultivariateNormal$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
MultivariateNormal$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
    Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula

\[ var_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
MultivariateNormal$variance(...)

Arguments:
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by

\[-\sum(f_X)\log(f_X)\]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
MultivariateNormal$entropy(base = 2, ...)

Arguments:
base (integer(1))
    Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X[exp(\lambda t)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
MultivariateNormal$mgf(t, ...)

Arguments:
Method \texttt{cf()}: The characteristic function is defined by
\[ cf_X(t) = E_X[exp(x t i)] \]
where \(X\) is the distribution and \(E_X\) is the expectation of the distribution \(X\).

Usage:
MultivariateNormal$cf(t, ...)

Arguments:
t \text{(integer(1))}
\( t \) integer to evaluate function at.
... Unused.

Method \texttt{pgf()}: The probability generating function is defined by
\[ pgf_X(z) = E_X[exp(z x)] \]
where \(X\) is the distribution and \(E_X\) is the expectation of the distribution \(X\).

Usage:
MultivariateNormal$pgf(z, ...)

Arguments:
z \text{(integer(1))}
\( z \) integer to evaluate probability generating function at.
... Unused.

Method \texttt{getParameterValue()}: Returns the value of the supplied parameter.

Usage:
MultivariateNormal$getParameterValue(id, error = "warn")

Arguments:
id \text{character()}
\( id \) of parameter support to return.
error \text{character(1))}
If "warn" then returns a warning on error, otherwise breaks if "stop".

Method \texttt{setParameterValue()}: Sets the value(s) of the given parameter(s).

Usage:
MultivariateNormal$setParameterValue(
\ldots,
lst = NULL,
error = "warn",
resolveConflicts = FALSE
)

Arguments:
Named arguments of parameters to set values for. See examples.

lst (list(1))
Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.

error (character(1))
If "warn" then returns a warning on error, otherwise breaks if "stop".

resolveConflicts (logical(1))
If FALSE (default) throws error if conflicting parameterisations are provided, otherwise automatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
MultivariateNormal$clone(deep = FALSE)

Arguments:
deepl Whether to make a deep clone.

References


See Also
Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Log Logistic, Lognormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other multivariate distributions: Dirichlet, EmpiricalMV, Multinomial

Description
Mathematical and statistical functions for the Negative Binomial distribution, which is commonly used to model the number of successes, trials or failures before a given number of failures or successes.
The Negative Binomial distribution parameterised with number of failures before successes, $n$, and probability of success, $p$, is defined by the pmf,

$$f(x) = C(x + n - 1, n - 1)p^n(1 - p)^x$$

for $n = 0, 1, 2, \ldots$ and probability $p$, where $C(a, b)$ is the combination (or binomial coefficient) function.

The Negative Binomial distribution can refer to one of four distributions (forms):

1. The number of failures before $K$ successes (fbs)
2. The number of successes before $K$ failures (sbf)
3. The number of trials before $K$ failures (tbf)
4. The number of trials before $K$ successes (tbs)

For each we refer to the number of $K$ successes/failures as the size parameter.

Note that the size parameter is not currently vectorised in VectorDistributions.

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on $0, 1, 2, \ldots$ (for fbs and sbf) or $n, n + 1, n + 2, \ldots$ (for tbf and tbs) (see below).

Default Parameterisation

NBinom(size = 10, prob = 0.5, form = "fbs")

Omitted Methods

N/A

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> NegativeBinomial

Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.
packages  Packages required to be installed in order to construct the distribution.
Methods

Public methods:

- NegativeBinomial$new()
- NegativeBinomial$mean()
- NegativeBinomial$mode()
- NegativeBinomial$variance()
- NegativeBinomial$skewness()
- NegativeBinomial$kurtosis()
- NegativeBinomial$mgf()
- NegativeBinomial$cf()
- NegativeBinomial$pgf()
- NegativeBinomial$setParameterValue()
- NegativeBinomial$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
NegativeBinomial$new(
  size = NULL,
  prob = NULL,
  qprob = NULL,
  mean = NULL,
  form = NULL,
  decorators = NULL
)

Arguments:

- size (integer(1))
  Number of trials/successes.
- prob (numeric(1))
  Probability of success.
- qprob (numeric(1))
  Probability of failure. If provided then prob is ignored. qprob = 1 -prob.
- mean (numeric(1))
  Mean of distribution, alternative to prob and qprob.
- form character(1))
  Form of the distribution, cannot be changed after construction. Options are to model the number of,
  - "fbs" - Failures before successes.
  - "sbf" - Successes before failures.
  - "tbf" - Trials before failures.
  - "tbs" - Trials before successes. Use $description to see the Negative Binomial form.
- decorators (character())
  Decorators to add to the distribution during construction.
Method mean(): The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

$$E_X(X) = \sum p_X(x) \ast x$$

with an integration analogue for continuous distributions.

Usage:
NegativeBinomial$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
NegativeBinomial$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula

$$var_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution $X$. If the distribution is multivariate the covariance matrix is returned.

Usage:
NegativeBinomial$variance(...)

Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

$$sk_X = E_X\left[\frac{x - \mu^3}{\sigma}\right]$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution.

Usage:
NegativeBinomial$skewness(...)

Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

$$k_X = E_X\left[\frac{x - \mu^4}{\sigma}\right]$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.
Usage:
NegativeBinomial$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))
    If TRUE (default) excess kurtosis returned.
... Unused.

Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X[exp(tX)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
NegativeBinomial$mgf(t, ...)

Arguments:
t (integer(1))
    t integer to evaluate function at.
... Unused.

Method cf(): The characteristic function is defined by

\[ cf_X(t) = E_X[exp(tiX)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
NegativeBinomial$cf(t, ...)

Arguments:
t (integer(1))
    t integer to evaluate function at.
... Unused.

Method pgf(): The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(zX)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
NegativeBinomial$pgf(z, ...)

Arguments:
z (integer(1))
    z integer to evaluate probability generating function at.
... Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
NegativeBinomial$setParameterValue(
  ..., 
  lst = NULL,
  error = "warn",
  resolveConflicts = FALSE
)

Arguments:

... ANY
  Named arguments of parameters to set values for. See examples.
lst (list(1))
  Alternative argument for passing parameters. List names should be parameter names and
  list values are the new values to set.
error (character(1))
  If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
  If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
  tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:

NegativeBinomial$clone(deep = FALSE)

Arguments:

deep Whether to make a deep clone.

References

Michael P. McLaughlin.

See Also

Other discrete distributions: Bernoulli, Binomial, Categorical, Degenerate, DiscreteUniform,
EmpiricalMV, Empirical, Geometric, Hypergeometric, Logarithmic, Multinomial, WeightedDiscrete

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical,
Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang,
Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz,
Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal,
Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT,
Triangular, Uniform, Wald, Weibull, WeightedDiscrete
Normal Distribution Class

Description

Mathematical and statistical functions for the Normal distribution, which is commonly used in significance testing, for representing models with a bell curve, and as a result of the central limit theorem.

Details

The Normal distribution parameterised with variance, $\sigma^2$, and mean, $\mu$, is defined by the pdf,

$$f(x) = \exp\left(-\frac{(x - \mu)^2}{2\sigma^2}\right) / \sqrt{2\pi\sigma^2}$$

for $\mu \in \mathbb{R}$ and $\sigma^2 > 0$.

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on the Reals.

Default Parameterisation

Norm(mean = 0, var = 1)

Omitted Methods

N/A

Also known as

Also known as the Gaussian distribution.

Super classes

distr6::Distribution -> distr6::SDistribution -> Normal

Public fields

name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.
Methods

Public methods:

- Normal$new()
- Normal$mean()
- Normal$mode()
- Normal$variance()
- Normal$skewness()
- Normal$kurtosis()
- Normal$entropy()
- Normal$mgf()
- Normal$cf()
- Normal$pgf()
- Normal$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Normal$new(mean = NULL, var = NULL, sd = NULL, prec = NULL, decorators = NULL)

Arguments:
mean (numeric(1))
  Mean of the distribution, defined on the Reals.
var (numeric(1))
  Variance of the distribution, defined on the positive Reals.
sd (numeric(1))
  Standard deviation of the distribution, defined on the positive Reals. \( sd = \sqrt{\text{var}} \). If provided then var ignored.
prec (numeric(1))
  Precision of the distribution, defined on the positive Reals. \( \text{prec} = 1/\text{var} \). If provided then var ignored.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution \( X \) is the expectation

\[
E_X(X) = \sum p_X(x) \times x
\]

with an integration analogue for continuous distributions.

Usage:
Normal$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Normal$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
  Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula
\[
\text{var}_X = E[X^2] - E[X]^2
\]
where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
Normal$variance(...) 
Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,
\[
sk_X = E_{X} \left( \frac{x - \mu}{\sigma} \right)^3
\]
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
Normal$skewness(...) 
Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,
\[
k_X = E_{X} \left( \frac{x - \mu}{\sigma} \right)^4
\]
where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
Normal$kurtosis(excess = TRUE, ...) 
Arguments:
excess (logical(1))
  If TRUE (default) excess kurtosis returned.
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by
\[
- \sum (f_X) log(f_X)
\]
where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.
Usage:
`Normal$entropy(base = 2, ...)`

Arguments:
- `base (integer(1))`
  - Base of the entropy logarithm, default = 2 (Shannon entropy)
  - ... Unused.

Method `mgf()`: The moment generating function is defined by

\[ mgf_X(t) = E_X[exp(xt)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
`Normal$mgf(t, ...)`

Arguments:
- `t (integer(1))`
  - \( t \) integer to evaluate function at.
  - ... Unused.

Method `cf()`: The characteristic function is defined by

\[ cf_X(t) = E_X[exp(xti)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
`Normal$cf(t, ...)`

Arguments:
- `t (integer(1))`
  - \( t \) integer to evaluate function at.
  - ... Unused.

Method `pgf()`: The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(xz)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
`Normal$pgf(z, ...)`

Arguments:
- `z (integer(1))`
  - \( z \) integer to evaluate probability generating function at.
  - ... Unused.

Method `clone()`: The objects of this class are cloneable with this method.

Usage:
`Normal$clone(deep = FALSE)`

Arguments:
- `deep` Whether to make a deep clone.
NormalKernel

References

See Also
Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

NormalKernel

Description
Mathematical and statistical functions for the NormalKernel kernel defined by the pdf,

\[ f(x) = \frac{\exp(-x^2/2)}{\sqrt{2\pi}} \]

over the support \( x \in \mathbb{R} \).

Details
We use the \texttt{erf} and \texttt{erfinv} error and inverse error functions from \texttt{pracma}.

Super classes
\texttt{distr6::Distribution} \rightarrow \texttt{distr6::Kernel} \rightarrow \text{NormalKernel}

Public fields
name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.
**Methods**

**Public methods:**
- `NormalKernel$new()`
- `NormalKernel$pdfSquared2Norm()`
- `NormalKernel$variance()`
- `NormalKernel$clone()`

**Method `new()`**: Creates a new instance of this R6 class.

*Usage:*
`NormalKernel$new(decorators = NULL)`

*Arguments:*
- `decorators` (character())
  Decorators to add to the distribution during construction.

**Method `pdfSquared2Norm()`**: The squared 2-norm of the pdf is defined by
\[
\int_{a}^{b} (f_X(u))^2 du
\]
where X is the Distribution, \( f_X \) is its pdf and \( a, b \) are the distribution support limits.

*Usage:*
`NormalKernel$pdfSquared2Norm(x = 0, upper = Inf)`

*Arguments:*
- `x` (numeric(1))
  Amount to shift the result.
- `upper` (numeric(1))
  Upper limit of the integral.

**Method `variance()`**: The variance of a distribution is defined by the formula
\[
var_X = E[X^2] - E[X]^2
\]
where \( E_X \) is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

*Usage:*
`NormalKernel$variance(...)`

*Arguments:*
- `...` Unused.

**Method `clone()`**: The objects of this class are cloneable with this method.

*Usage:*
`NormalKernel$clone(deep = FALSE)`

*Arguments:*
- `deep` Whether to make a deep clone.

**See Also**
- Other kernels: Cosine, Epanechnikov, LogisticKernel, Quartic, Sigmoid, Silverman, TriangularKernel, Tricube, Triweight, UniformKernel
parameters

<table>
<thead>
<tr>
<th>parameters</th>
<th>Parameters Accessor</th>
</tr>
</thead>
</table>

**Description**

Returns some or all the parameters in a distribution.

**Usage**

`parameters(object, id = NULL)`

**Arguments**

- `object` Distribution or ParameterSet.
- `id` character, see details.

**Value**

An R6 object of class ParameterSet or a data.table.

---

**ParameterSet**

Parameter Sets for Distributions

<table>
<thead>
<tr>
<th>ParameterSet</th>
<th>Parameter Sets for Distributions</th>
</tr>
</thead>
</table>

**Description**

ParameterSets are passed to the `Distribution` constructor when creating a custom probability distribution that takes parameters.

**Active bindings**

- `deps` Returns ParameterSet dependencies table.
- `checks` Returns ParameterSet assertions table.
- `trafos` Returns ParameterSet transformations table.
- `length` Number of parameters in ParameterSet.

**Methods**

Public methods:

- `ParameterSet$new()`
- `ParameterSet$print()`
- `ParameterSet$parameters()`
- `ParameterSet$getParameterSupport()`
- `ParameterSet$getParameterValue()`
ParameterSet$setParameterValue()
ParameterSet$merge()
ParameterSet$addDeps()
ParameterSet$addChecks()
ParameterSet$addTrafos()
ParameterSet$values()
ParameterSet$clone()

**Method new():** Creates a new instance of this R6 class.

**Usage:**
ParameterSet$new(id = id,
                value = value,
                support = support,
                settable = TRUE,
                updateFunc = NULL,
                description = NULL)

**Arguments:**
- `id` (character(1)|list())
  id of the parameter(s) to construct, should be unique.
- `value` (ANY|list())
  Value of parameter(s) to set.
- `support` ([set6::Set]|list())
  Support of parameter(s) to set
- `settable` (character(1)|list())
  Logical flag indicating if the parameter(s) can be updated after construction.
- `updateFunc` (list())
  Deprecated, please use $addDeps instead.
- `description` (character(1)|list())
  Optional description for the parameter(s).

**Details:** Every argument can either be given as the type listed or as a list of that type. If arguments are provided as a list, then each argument must be of the same length, with values as NULL where appropriate. See examples for more.

**Examples:**
```r
id <- list("prob", "size")
value <- list(0.2, 5)
support <- list(set6::Interval$new(0, 1), set6::PosNaturals$new())
description <- list("Probability of success", NULL)
ParameterSet$new(id = id,
                  value = value,
                  support = support,
                  description = description)
```
ParameterSet$new(id = "prob",
  value = 0.2,
  support = set6::Interval$new(0, 1),
  description = "Probability of success"
)

**Method** `print()`: Prints the `ParameterSet`.

*Usage:*

`ParameterSet$print(hide_cols = c("settable"), ...)`

*Arguments:*

`hide_cols` (character())
  - Names of columns in the `ParameterSet` to hide whilst printing.

`...` ANY
  - Additional arguments, currently unused.

**Method** `parameters()`: Returns the full parameter details for the supplied parameter, or returns `self` if `id` is `NULL`.

*Usage:*

`ParameterSet$parameters(id = NULL)`

*Arguments:*

`id` character()
  - id of parameter to return.

**Method** `getParameterSupport()`: Returns the support of the supplied parameter.

*Usage:*

`ParameterSet$getParameterSupport(id, error = "warn")`

*Arguments:*

`id` character()
  - id of parameter support to return.

`error` (character(1))
  - If "warn" then returns a warning on error, otherwise breaks if "stop".

*Returns: A set6::Set object.

*Examples:*

```r
ps <- ParameterSet$new(id = "prob",
  value = 0.2,
  support = set6::Interval$new(0, 1),
  settable = TRUE,
  description = "Probability of success"
)
ps$getParameterSupport("prob")
```

**Method** `getParameterValue()`: Returns the value of the supplied parameter.

*Usage:*

`ParameterSet$getParameterValue(id, error = "warn")`
**ParameterSet**

**Arguments:**

id character()

   id of parameter value to return.

error (character(1))

   If "warn" then returns a warning on error, otherwise breaks if "stop".

**Examples:**

```r
ps <- ParameterSet$new(id = "prob",
   value = 0.2,
   support = set6::Interval$new(0, 1),
   settable = TRUE,
   description = "Probability of success"
)
ps$getParameterValue("prob")
```

**Method** setParameterValue(): Sets the value(s) of the given parameter(s).

**Usage:**

```r
ParameterSet$setParameterValue(
   ...,
   lst = NULL,
   error = "warn",
   .suppressCheck = FALSE,
   resolveConflicts = FALSE
)
```

**Arguments:**

... ANY

   Named arguments of parameters to set values for. See examples.

lst (list(1))

   Alternative argument for passing parameters. List names should be parameter names and
   list values are the new values to set.

error (character(1))

   If "warn" then returns a warning on error, otherwise breaks if "stop".

.suppressCheck (logical(1))

   Should be set internally only.

.resolveConflicts (logical(1))

   If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
   tomatically resolves them by removing all conflicting parameters.

**Examples:**

```r
id <- list("rate")
value <- list(1)
support <- list(set6::PosReals$new())
ps <- ParameterSet$new(
   id, value, support
)
ps$setParameterValue(rate = 2)
ps$getParameterValue("rate")
```
**Method** `merge()`: Merges multiple parameter sets.

*Usage:*

```r
ParameterSet$merge(y, ...)
```

*Arguments:*

- `y` ([ParameterSet])
- `...` ([ParameterSet]s)

*Examples:*

```r
dontrun{
  ps1 <- ParameterSet$new(id = c("prob", "qprob"),
    value = c(0.2, 0.8),
    support = list(set6::Interval$new(0, 1), set6::Interval$new(0, 1))
  )
  ps1$addChecks(function(self) self$getParameterValue("x") > 0)
  ps1$addDeps("prob", "qprob", function(self)
    list(qprob = 1 - self$getParameterValue("prob")))
  ps2 <- ParameterSet$new(id = "size",
    value = 10,
    support = set6::Interval$new(0, 10, class = "integer"),
  )
  ps2$addTrafos("size", function(x, self) x + 1)
  ps1$merge(ps2)
  ps1$print()
}
```

**Method** `addDeps()`: Add parameter dependencies for automatic updating.

*Usage:*

```r
ParameterSet$addDeps(x, y, fun)
```

*Arguments:*

- `x` (character(1))
  - id of parameter that updates `y`.
- `y` (character())
  - id of parameter(s) that is/are updated by `x`.
- `fun` (function(1))
  - Function used to update `y`, must include `self` in formal arguments and should return a named list with names identical to, and in the same order, as `y`.

*Examples:*

```r
dontrun{
  ps <- ParameterSet$new(
    id = list("a", "b", "c"),
    value = list(2, 3, 1/2),
    support = list(set6::Reals$new(), set6::Reals$new(), set6::Reals$new())
  )
  ps$addDeps("a", c("b", "c"),
    function(self) {
      list(b = self$getParameterValue("a") + 1,
```

```r
```
ParameterSet

```r
c = 1/self$getParameterValue("a")
```

Method `addChecks()`: Add parameter checks for automatic assertions. Note checks are made after any transformations.

Usage:
```r
ParameterSet$addChecks(fun)
```

Arguments:
- `fun` (function(1))
  - Function used to check `ParameterSet`, must include `self` in formal arguments and result in a logical.

Examples:
```r
\dontrun{
id <- list("lower", "upper")
value <- list(1, 3)
support <- list(set6::PosReals$new(), set6::PosReals$new())
ps <- ParameterSet$new(
  id, value, support
)
ps$addChecks(function(self)
  self$getParameterValue("lower") < self$getParameterValue("upper")
}
```

Method `addTrafos()`: Transformations to apply to parameter before setting. Note transformations are made before checks. NOTE: If a transformation for a parameter already exists then this will be overwritten.

Usage:
```r
ParameterSet$addTrafos(x, fun, dt = NULL)
```

Arguments:
- `x` (character(1))
  - id of parameter to be transformed. Only one trafo function per parameter allowed - though multiple transformations can be encoded within this.
- `fun` (function(1))
  - Function used to transform `x`, must include `x, self` in formal arguments and `x` in body where `x` is the value of the parameter to check. See first example.
- `dt` ([data.table::data.table])
  - Alternate method to directly construct `data.table` of transformations to add. See second example.

Examples:
```r
\dontrun{
ps <- ParameterSet$new(
  "probs", list(c(1, 1)), set6::Interval$new(0,1)^2
)
ps$addTrafos("probs", function(x, self) return(x / sum(x)))
```
```r	ps$trafos
ps$setParameterValue(probs = c(1, 2))
ps$getParameterValue("probs")

# Alternate method (better with more parameters)
ps <- ParameterSet$new(
  "probs", list(c(1, 1)), set6::Interval$new(0,1)^2
)
ps$addTrafos(dt = data.table::data.table(
  x = "probs",
  fun = function(x, self) return(x / sum(x))
))
```

**Method `values()`**: Returns parameter set values as a named list.

*Usage:*
```r
ParameterSet$values(settable = TRUE)
```

*Arguments:*
```r
settable (logical(1))
```
If TRUE (default) only returns values of settable parameters.

**Method `clone()`**: The objects of this class are cloneable with this method.

*Usage:*
```r
ParameterSet$clone(deep = FALSE)
```

*Arguments:*
```r
deep Whether to make a deep clone.
```

### Examples
```r
## Method `ParameterSet$new`
```
```r
id <- list("prob", "size")
value <- list(0.2, 5)
support <- list(set6::Interval$new(0, 1), set6::PosNaturals$new())
description <- list("Probability of success", NULL)
ParameterSet$new(id = id,
  value = value,
  support = support,
  description = description
)
```
```r
ParameterSet$new(id = "prob",
  value = 0.2,
  support = set6::Interval$new(0, 1),
  description = "Probability of success"
)```
## Method `ParameterSet$getParameterSupport`
```
ps <- ParameterSet$new(id = "prob",
                    value = 0.2,
                    support = set6::Interval$new(0, 1),
                    settable = TRUE,
                    description = "Probability of success"
)
ps$getParameterSupport("prob")
```

## Method `ParameterSet$getParameterValue`
```
ps <- ParameterSet$new(id = "prob",
                    value = 0.2,
                    support = set6::Interval$new(0, 1),
                    settable = TRUE,
                    description = "Probability of success"
)
ps$getParameterValue("prob")
```

## Method `ParameterSet$setParameterValue`
```
id <- list("rate")
value <- list(1)
support <- list(set6::PosReals$new())
ps <- ParameterSet$new(id, value, support)
ps$setParameterValue(rate = 2)
ps$getParameterValue("rate")
```

## Method `ParameterSet$merge`
```
## Not run:
ps1 <- ParameterSet$new(id = c("prob", "qprob"),
                    value = c(0.2, 0.8),
                    support = list(set6::Interval$new(0, 1), set6::Interval$new(0, 1)))
ps1$addChecks(function(self) self$getParameterValue("x") > 0)
ps1$addDeps("prob", "qprob", function(self)
    list(qprob = 1 - self$getParameterValue("prob")))
ps2 <- ParameterSet$new(id = "size",
                    value = 10,
                    support = set6::Interval$new(0, 10, class = "integer"),
```
ParameterSet

) ps2$addTrafos("size", function(x, self) x + 1) ps1$merge(ps2) ps1$print()

## End(Not run)

## Method `ParameterSet$addDeps`

## Not run:
ps <- ParameterSet$new( id = list("a", "b", "c"), value = list(2, 3, 1/2), support = list(set6::Reals$new(), set6::Reals$new(), set6::Reals$new()) ) ps$addDeps("a", c("b", "c"), function(self) { list(b = self$getParameterValue("a") + 1, c = 1/self$getParameterValue("a")) })

## End(Not run)

## Method `ParameterSet$addChecks`

## Not run:
id <- list("lower", "upper") value <- list(1, 3) support <- list(set6::PosReals$new(), set6::PosReals$new()) ps <- ParameterSet$new( id, value, support ) ps$addChecks(function(self) self$getParameterValue("lower") < self$getParameterValue("upper"))

## End(Not run)

## Method `ParameterSet$addTrafos`

## Not run:
ps <- ParameterSet$new( "probs", list(c(1, 1)), set6::Interval$new(0, 1)^2 ) ps$addTrafos("probs", function(x, self) return(x / sum(x))) ps$trafos ps$setParameterValue(probs = c(1, 2)) ps$getParameterValue("probs")
# Alternate method (better with more parameters)
ps <- ParameterSet$new(
  "probs", list(c(1, 1)), set6::Interval$new(0,1)^2
)
ps$addTrafos(dt = data.table::data.table(
  x = "probs",
  fun = function(x, self) return(x / sum(x))
))
## End(Not run)

### Description

ParameterSetCollection is used to combine multiple ParameterSets in wrapped distributions. Generally only need to be constructed internally.

### Super class

distr6::ParameterSet -> ParameterSetCollection

### Active bindings

deps  Returns ParameterSet dependencies table.
parameterSets  Returns ParameterSets in collection.

### Methods

#### Public methods:

- ParameterSetCollection$new()
- ParameterSetCollection$print()
- ParameterSetCollection$parameters()
- ParameterSetCollection$getParameterValue()
- ParameterSetCollection$getParameterSupport()
- ParameterSetCollection$setParameterValue()
- ParameterSetCollection$merge()
- ParameterSetCollection$addDeeps()
- ParameterSetCollection$values()
- ParameterSetCollection$clone()

#### Method new():

Creates a new instance of this R6 class.

*Usage:*
ParameterSetCollection$new(..., lst = NULL, .checks = NULL, .supports = NULL)
Arguments:
... ([ParameterSet])
ParameterSets to combine into a collection. Should be supplied as named arguments where
the names are unique and correspond to references for the distributions.
lst (list())
Alternative constructor by supplying a named list of ParameterSets.
.checks Used internally.
.supports Used internally.
Examples:
b = Binomial$new()
g = Geometric$new()
ParameterSetCollection$new(Binom1 = b$parameters(),
                          Binom2 = b$parameters(),
                          Geom = g$parameters())

ParameterSetCollection$new(lst = list(Binom1 = b$parameters(),
                          Binom2 = b$parameters(),
                          Geom = g$parameters()))

Method print(): Prints the ParameterSetCollection.
Usage:
ParameterSetCollection$print(hide_cols = c("settable"), ...)
Arguments:
hide_cols (character())
  Names of columns in the ParameterSet to hide whilst printing.
... ANY
  Additional arguments, currently unused.

Method parameters(): Returns the full parameter details for the supplied parameter, or returns
self if id is NULL or unmatched.
Usage:
ParameterSetCollection$parameters(id = NULL)
Arguments:
id character()
  id of parameter to return.

Method getParameterValue(): Returns the value of the supplied parameter.
Usage:
ParameterSetCollection$getParameterValue(id, error = "warn")
Arguments:
id (character(1)) To return the parameter for a specific distribution, use the parameter ID
  with the distribution name prefix, otherwise to return the parameter for all distributions omit
  the prefix. See examples.
error (character(1))

If "warn" then returns a warning on error, otherwise breaks if "stop".

Examples:
psc <- ParameterSetCollection$new(Binom1 = Binomial$new()$parameters(),
    Binom2 = Binomial$new()$parameters(),
    Geom = Geometric$new()$parameters())
psc$getParameterValue("Binom1__prob")
psc$getParameterValue("prob")

Method getParameterSupport(): Returns the support of the supplied parameter.

Usage:
ParameterSetCollection$getParameterSupport(id, error = "warn")

Arguments:
id character()
    id of parameter support to return.
error (character(1))
    If "warn" then returns a warning on error, otherwise breaks if "stop".

Returns: A set6::Set object.

Examples:
b <- Binomial$new()
g <- Geometric$new()
psc <- ParameterSetCollection$new(Binom1 = b$parameters(),
    Binom2 = b$parameters(),
    Geom = g$parameters())
psc$getParameterSupport("Binom1__prob")

Method setParameterValue(): Sets the value(s) of the given parameter(s). Because of R6
reference semantics this also updates the ParameterSet of the wrapped distibution, and vice versa. See examples.

Usage:
ParameterSetCollection$setParameterValue(
    ...,
    lst = NULL,
    error = "warn",
    resolveConflicts = FALSE
)

Arguments:
... ANY
    Named arguments of parameters to set values for. See examples.
lst (list(1))
    Alternative argument for passing parameters. List names should be parameter names and
    list values are the new values to set.
error (character(1))
    If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
If FALSE (default) throws error if conflicting parameterisations are provided, otherwise automatically resolves them by removing all conflicting parameters.

Examples:
b <- Binomial$new()
g <- Geometric$new()
psc <- ParameterSetCollection$new(Binom1 = b$parameters(),
                                  Binom2 = b$parameters(),
                                  Geom = g$parameters())

psc$getParameterValue("Binom1__prob")
b$getParameterValue("prob")
psc$setParameterValue(Binom1__prob = 0.4)
# both updated
psc$getParameterValue("Binom1__prob")
b$getParameterValue("prob")

g$setParameterValue(prob = 0.1)
# both updated
psc$getParameterValue("Geom__prob")
g$getParameterValue("prob")

Method merge(): Merges other ParameterSetCollections into self.

Usage:
ParameterSetCollection$merge(..., lst = NULL)

Arguments:
... ([ParameterSetCollection])
lst (list(1))
  Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.
‘lst’ (list())
  Alternative method of passing a list of ParameterSetCollections.

Examples:
b <- Binomial$new()
g <- Geometric$new()
psc <- ParameterSetCollection$new(Binom = b$parameters())
psc2 <- ParameterSetCollection$new(Geom = g$parameters())
psc$merge(psc2)$parameters()

Method addDeps(): Dependencies should be added to internal ParameterSets.

Usage:
ParameterSetCollection$addDeps(...)

Arguments:
... ANY
  Ignored.
**Method** values(): Returns parameter set values as a named list.

*Usage:*

`ParameterSetCollection$values(settable = TRUE)`

*Arguments:*

- `settable` (logical(1))
  
  If TRUE (default) only returns values of settable parameters, otherwise returns all.

**Method** clone(): The objects of this class are cloneable with this method.

*Usage:*

`ParameterSetCollection$clone(deep = FALSE)`

*Arguments:*

- `deep` (logical(1))
  
  Whether to make a deep clone.

### Examples

```r
## Method `ParameterSetCollection$new`

b = Binomial$new()
g = Geometric$new()
ParameterSetCollection$new(Binom1 = b$parameters(),
                         Binom2 = b$parameters(),
                         Geom = g$parameters())

ParameterSetCollection$new(lst = list(Binom1 = b$parameters(),
                                     Binom2 = b$parameters(),
                                     Geom = g$parameters()))

## Method `ParameterSetCollection$getParameterValue`

psc <- ParameterSetCollection$new(Binom1 = Binomial$new()$parameters(),
                                  Binom2 = Binomial$new()$parameters(),
                                  Geom = Geometric$new()$parameters())

psc$getParameterValue("Binom1__prob")
psc$getParameterValue("prob")

## Method `ParameterSetCollection$getParameterSupport`

b = Binomial$new()
g = Geometric$new()
p = ParameterSetCollection$new(Binom1 = b$parameters(),
                              Binom2 = b$parameters(),
                              Geom = g$parameters())
p$support("Binom1__prob")
```
Pareto

---

## Method `ParameterSetCollection$setParameterValue`

```r
b <- Binomial$new()
g <- Geometric$new()
psc <- ParameterSetCollection$new(Binom1 = b$parameters(),
                                  Binom2 = b$parameters(),
                                  Geom = g$parameters())

psc$getParameterValue("Binom1__prob")
b$getParameterValue("prob")
psc$setParameterValue(Binom1__prob = 0.4)
# both updated
psc$getParameterValue("Binom1__prob")
b$getParameterValue("prob")

g$setParameterValue(prob = 0.1)
# both updated
psc$getParameterValue("Geom__prob")
g$getParameterValue("prob")

---

## Method `ParameterSetCollection$merge`

```r
b <- Binomial$new()
g <- Geometric$new()
psc <- ParameterSetCollection$new(Binom = b$parameters())
psc2 <- ParameterSetCollection$new(Geom = g$parameters())
pscmerge(psc2)$parameters()
```

---

Pareto Distribution Class

**Description**

Mathematical and statistical functions for the Pareto distribution, which is commonly used in Economics to model the distribution of wealth and the 80-20 rule.

**Details**

The Pareto distribution parameterised with shape, $\alpha$, and scale, $\beta$, is defined by the pdf,

$$ f(x) = (\alpha \beta^\alpha) / (x^{\alpha + 1}) $$

for $\alpha, \beta > 0$.

Currently this is implemented as the Type I Pareto distribution, other types will be added in the future. Characteristic function is omitted as no suitable incomplete gamma function with complex inputs implementation could be found.
Pareto

Value
Returns an R6 object inheriting from class SDistribution.

Distribution support
The distribution is supported on \([\beta, \infty)\).

Default Parameterisation
Pare(shape = 1, scale = 1)

Omitted Methods
N/A

Also known as
N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> Pareto

Public fields
name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.

Methods

Public methods:
- Pareto$new()
- Pareto$mean()
- Pareto$mode()
- Pareto$median()
- Pareto$variance()
- Pareto$skewness()
- Pareto$kurtosis()
- Pareto$entropy()
- Pareto$mgf()
- Pareto$pgf()
- Pareto$setParameterValue()
- Pareto$clone()

Method new(): Creates a new instance of this R6 class.
Usage:
Pareto$new(shape = NULL, scale = NULL, decorators = NULL)

Arguments:
shape (numeric(1))
    Shape parameter, defined on the positive Reals.
scale (numeric(1))
    Scale parameter, defined on the positive Reals.
decorators (character())
    Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

$$ E_X(X) = \sum p_X(x) \cdot x $$

with an integration analogue for continuous distributions.

Usage:
Pareto$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Pareto$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
    Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method median(): Returns the median of the distribution. If an analytical expression is available returns distribution median, otherwise if symmetric returns self$mean, otherwise returns self$quantile(0.5).

Usage:
Pareto$median()

Method variance(): The variance of a distribution is defined by the formula

$$ var_X = E[X^2] - E[X]^2 $$

where $E_X$ is the expectation of distribution $X$. If the distribution is multivariate the covariance matrix is returned.

Usage:
Pareto$variance(...)

Arguments:
... Unused.
Method skewness(): The skewness of a distribution is defined by the third standardised moment,

\[ sk_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
Pareto$skewness(...)

Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
Pareto$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))  
If TRUE (default) excess kurtosis returned.
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by

\[-\sum (f_X) \log(f_X)\]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
Pareto$entropy(base = 2, ...)

Arguments:
base (integer(1))  
Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X [\exp(tx)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Pareto$mgf(t, ...)

Arguments:
Method \texttt{pgf()}: The probability generating function is defined by
\[ pgf_X(z) = E_X[exp(z^x)] \]
where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Pareto$pgf(z, \ldots)

Arguments:
z (integer(1))
  z integer to evaluate probability generating function at.
... Unused.

Method \texttt{setParameterValue()}: Sets the value(s) of the given parameter(s).

Usage:
Pareto$setParameterValue(
  ..., 
  lst = NULL, 
  error = "warn", 
  resolveConflicts = FALSE 
)

Arguments:
... ANY
  Named arguments of parameters to set values for. See examples.
lst (list(1))
  Alternative argument for passing parameters. List names should be parameter names and
  list values are the new values to set.
error (character(1))
  If "warn" then returns a warning on error, otherwise breaks if "stop".
resolveConflicts (logical(1))
  If FALSE (default) throws error if conflicting parameterisations are provided, otherwise
  automatically resolves them by removing all conflicting parameters.

Method \texttt{clone()}: The objects of this class are cloneable with this method.

Usage:
Pareto$clone(deep = FALSE)

Arguments:
deep  Whether to make a deep clone.

References
Michael P. McLaughlin.
pdf

Probability Density Function

See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Poisson, Rayleigh, ShiftedLogLogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Poisson, Rayleigh, ShiftedLogLogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

Description

See Distribution$pdf

Usage

pdf(object, ..., log = FALSE, simplify = TRUE, data = NULL)

Arguments

object (Distribution)

... (numeric())

Points to evaluate the probability density function of the distribution. Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

log logical(1)

If TRUE returns log-pdf. Default is FALSE.

simplify logical(1)

If TRUE (default) simplifies the pdf if possible to a numeric, otherwise returns a data.table::data.table.

data array

Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

Value

Pdf evaluated at given points as either a numeric if simplify is TRUE or as a data.table::data.table.
pdfPNorm  

**Description**  
The p-norm of the pdf evaluated between given limits or over the whole support.

**Usage**  
```
pdfPNorm(object, p = 2, lower = NULL, upper = NULL)
```

**Arguments**  
- **object**  
  Distribution.
- **p**  
  p-norm to calculate.
- **lower**  
  lower limit for integration, default is infimum.
- **upper**  
  upper limit for integration, default is supremum.

**See Also**  
`ExoticStatistics` and `decorate`

---

pdfSquared2Norm  

**Description**  
The squared 2-norm of the pdf evaluated up to a given limit, possibly shifted.

**Usage**  
```
pdfSquared2Norm(object, x = 0, upper = Inf)
```

**Arguments**  
- **object**  
  Distribution.
- **x**  
  amount to shift the result.
- **upper**  
  upper limit of the integral.

**Value**  
Squared 2-norm of pdf evaluated between limits as a numeric.
Probability Generating Function

Description

Probability generating function of a distribution

Usage

pgf(object, z, ...)

Arguments

object Distribution.
z integer to evaluate characteristic function at.
... Passed to $genExp.

Value

Probability generating function evaluated at z as a numeric if distribution is discrete, otherwise NaN.

Plot Distribution Functions for a distr6 Object

Description

Six plots, which can be selected with fun are available for discrete and continuous univariate distributions: pdf, cdf, quantile, survival, hazard and cumulative hazard. By default, the first two are plotted side by side.

Usage

## S3 method for class 'Distribution'
plot(
x, fun = c("pdf", "cdf"), npoints = 3000,
plot = TRUE,
ask = FALSE,
arrange = TRUE,
... )
Arguments

- **x**: distr6 object.
- **fun**: vector of functions to plot, one or more of: "pdf", "cdf", "quantile", "survival", "hazard", "cumhazard", and "all"; partial matching available.
- **npoints**: number of evaluation points.
- **plot**: logical; if TRUE (default), figures are displayed in the plot window; otherwise a `data.table::data.table()` of points and calculated values is returned.
- **ask**: logical; if TRUE, the user is asked before each plot, see `graphics::par()`.
- **arrange**: logical; if TRUE (default), margins are automatically adjusted with `graphics::layout()` to accommodate all plotted functions.
- **...**: graphical parameters, see details.

Details

The evaluation points are calculated using inverse transform on a uniform grid between 0 and 1 with length given by `npoints`. Therefore any distribution without an analytical quantile method will first need to be imputed with the FunctionImputation decorator.

The order that the functions are supplied to `fun` determines the order in which they are plotted, however this is ignored if `ask` is TRUE. If `ask` is TRUE then `arrange` is ignored. For maximum flexibility in plotting layouts, set `arrange` and `ask` to FALSE.

The graphical parameters passed to `...` can either apply to all plots or selected plots. If parameters in `par` are prefixed with the plotted function name, then the parameter only applies to that function, otherwise it applies to them all. See examples for a clearer description.

Author(s)

Chengyang Gao, Runlong Yu and Shuhan Liu

See Also

- `lines.Distribution`

Examples

```r
## Not run:
# Plot pdf and cdf of Normal
plot(Normal$new())

# Colour both plots red
plot(Normal$new(), col = "red")

# Change the colours of individual plotted functions
plot(Normal$new(), pdf_col = "red", cdf_col = "green")

# Interactive plotting in order - par still works here
plot(Geometric$new(),
     fun = "all", ask = TRUE, pdf_col = "black",
..."
```
plot(VectorDistribution

### Plotting Distribution Functions for a VectorDistribution

*****

**Description**

Helper function to more easily plot distributions inside a VectorDistribution.

**Usage**

```r
## S3 method for class 'VectorDistribution'
plot(x, fun = "pdf", topn, ind, cols, ...)```

**Arguments**

- `x` 
  VectorDistribution.
- `fun` 
  function to plot, one of: "pdf","cdf","quantile", "survival", "hazard", "cumhazard".
- `topn` 
  integer. First n distributions in the VectorDistribution to plot.
- `ind` 
  integer. Indices of the distributions in the VectorDistribution to plot. If given then topn is ignored.
- `cols` 
  character. Vector of colours for plotting the curves. If missing 1:9 are used.
- `...` 
  Other parameters passed to plot.Distribution.

**Details**

If topn and ind are both missing then all distributions are plotted if there are 10 or less in the vector, otherwise the function will error.

**See Also**

plot.Distribution
Examples

```r
## Not run:
# Plot pdf of Normal distribution
vd <- VectorDistribution$new(list(Normal$new(), Normal$new(mean = 2)))
plot(vd)
plot(vd, fun = "surv")
plot(vd, fun = "quantile", ylim = c(-4, 4), col = c("blue", "purple"))
## End(Not run)
```

Poisson Distribution Class

Description

Mathematical and statistical functions for the Poisson distribution, which is commonly used to model the number of events occurring in at a constant, independent rate over an interval of time or space.

Details

The Poisson distribution parameterised with arrival rate, \( \lambda \), is defined by the pmf,

\[
 f(x) = \frac{(\lambda^x \cdot exp(-\lambda))}{x!}
\]

for \( \lambda > 0 \).

Value

Returns an R6 object inheriting from class `SDistribution`.

Distribution support

The distribution is supported on the Naturals.

Default Parameterisation

`Pois(rate = 1)`

Omitted Methods

N/A

Also known as

N/A

Super classes

`distr6::Distribution` \( \rightarrow \) `distr6::SDistribution` \( \rightarrow \) Poisson
Public fields

- name: Full name of distribution.
- short_name: Short name of distribution for printing.
- description: Brief description of the distribution.
- packages: Packages required to be installed in order to construct the distribution.

Methods

Public methods:

- Poisson$new()
- Poisson$mean()
- Poisson$mode()
- Poisson$variance()
- Poisson$skewness()
- Poisson$kurtosis()
- Poisson$mgf()
- Poisson$cf()
- Poisson$pgf()
- Poisson$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Poisson$new(rate = NULL, decorators = NULL)

Arguments:
rate (numeric(1))
  Rate parameter of the distribution, defined on the positive Reals.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) \cdot x \]

with an integration analogue for continuous distributions.

Usage:
Poisson$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Poisson$mode(which = "all")
Arguments:
which (character(1) | numeric(1))
  Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method variance(): The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
Poisson$variance(...)
Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

\[ \text{sk}_X = E_X \left[ \frac{x - \mu^3}{\sigma} \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
Poisson$skewness(...)
Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu^4}{\sigma} \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
Poisson$kurtosis(excess = TRUE, ...)
Arguments:
  excess (logical(1))
  If TRUE (default) excess kurtosis returned.
... Unused.

Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X [exp(x t)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).
Poisson

\texttt{Poisson$\text{mgf}(t, \ldots)$}

\textit{Arguments:}
\begin{itemize}
  \item \texttt{t} (integer(1))
    \hspace{1em} t integer to evaluate function at.
  \end{itemize}

\ldots Unused.

\textbf{Method \texttt{cf}():} The characteristic function is defined by

\[ cf_X(t) = E_X[exp(x t i)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

\textit{Usage:}
\texttt{Poisson$\text{cf}(t, \ldots)$}

\textit{Arguments:}
\begin{itemize}
  \item \texttt{t} (integer(1))
    \hspace{1em} t integer to evaluate function at.
  \end{itemize}

\ldots Unused.

\textbf{Method \texttt{pgf}():} The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(z x)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

\textit{Usage:}
\texttt{Poisson$\text{pgf}(z, \ldots)$}

\textit{Arguments:}
\begin{itemize}
  \item \texttt{z} (integer(1))
    \hspace{1em} z integer to evaluate probability generating function at.
  \end{itemize}

\ldots Unused.

\textbf{Method \texttt{clone}():} The objects of this class are cloneable with this method.

\textit{Usage:}
\texttt{Poisson$\text{clone}(\text{deep} = \text{FALSE})$}

\textit{Arguments:}
\begin{itemize}
  \item \texttt{deep} Whether to make a deep clone.
  \end{itemize}

\textbf{References}

See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

---

desc

Description

Precision of a distribution assuming variance is provided.

Usage

prec(object)

Arguments

object Distribution.

Value

Reciprocal of variance as a numeric.

---

print.ParameterSet

Description

Prints a ParameterSet as a data.table with strprint variants of R6 classes.

Usage

## S3 method for class 'ParameterSet'
print(x, hide_cols = c("settable"), ...)
ProductDistribution

Arguments

x ParameterSet
hide_cols string, if given the data.table is filtered to hide these columns
... ignored, added for S3 consistency

ProductDistribution  Product Distribution Wrapper

Description

A wrapper for creating the product distribution of multiple independent probability distributions.

Usage

## S3 method for class 'Distribution'
x * y

Arguments

x, y  Distribution

Details

A product distribution is defined by

$$F_P(X_1 = x_1, ..., X_N = x_N) = F_{X_1}(x_1) \times ... \times F_{X_N}(x_n)$$

#nolint where $F_P$ is the cdf of the product distribution and $X_1, ..., X_N$ are independent distributions.

Super classes

distr6::Distribution -> distr6::DistributionWrapper -> distr6::VectorDistribution -> ProductDistribution

Methods

Public methods:
• ProductDistribution$new()
• ProductDistribution$strprint()
• ProductDistribution$pdf()
• ProductDistribution$cdf()
• ProductDistribution$quantile()
• ProductDistribution$clone()

Method new(): Creates a new instance of this R6 class.
Usage:

ProductDistribution$new(
  distlist = NULL,
  distribution = NULL,
  params = NULL,
  shared_params = NULL,
  name = NULL,
  short_name = NULL,
  decorators = NULL,
  vecdist = NULL,
  ids = NULL
)

Arguments:

distlist (list())
  List of Distributions.

distribution (character(1))
  Should be supplied with params and optionally shared_params as an alternative to distlist. Much faster implementation when only one class of distribution is being wrapped. distribution is the full name of one of the distributions in listDistributions(), or "Distribution" if constructing custom distributions. See examples in VectorDistribution.

params (list()|data.frame())
  Parameters in the individual distributions for use with distribution. Can be supplied as a list, where each element is the list of parameters to set in the distribution, or as an object coercable to data.frame, where each column is a parameter and each row is a distribution. See examples in VectorDistribution.

shared_params (list())
  If any parameters are shared when using the distribution constructor, this provides a much faster implementation to list and query them together. See examples in VectorDistribution.

name (character(1))
  Optional name of wrapped distribution.

short_name (character(1))
  Optional short name/ID of wrapped distribution.

decorators (character())
  Decorators to add to the distribution during construction.

vecdist VectorDistribution
  Alternative constructor to directly create this object from an object inheriting from VectorDistribution.

ids (character())
  Optional ids for wrapped distributions in vector, should be unique and of same length as the number of distributions.

Examples:

\dontrun{
ProductDistribution$new(list(Binomial$new(
  prob = 0.5,
  size = 10
)
ProductDistribution

ProductDistribution$new(
  distribution = "Binomial",
  params = list(
    list(prob = 0.1, size = 2),
    list(prob = 0.6, size = 4),
    list(prob = 0.2, size = 6)
  )
)

# Equivalently
ProductDistribution$new(
  distribution = "Binomial",
  params = data.table::data.table(prob = c(0.1, 0.6, 0.2), size = c(2, 4, 6))
)

Method strprint(): Printable string representation of the ProductDistribution. Primarily used internally.

Usage:
ProductDistribution$strprint(n = 10)

Arguments:

n (integer(1))
  Number of distributions to include when printing.

Method pdf(): Probability density function of the product distribution. Computed by

\[ f_P(X_1 = x_1, ..., X_N = x_N) = \prod_i f_{X_i}(x_i) \]

where \( f_{X_i} \) are the pdfs of the wrapped distributions.

Usage:
ProductDistribution$pdf(..., log = FALSE, simplify = TRUE, data = NULL)

Arguments:

... (numeric())
  Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

log (logical(1))
  If TRUE returns the logarithm of the probabilities. Default is FALSE.

simplify logical(1)
  If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.

data array
  Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.
Examples:

```r
p <- ProductDistribution$new(list(
  Binomial$new(prob = 0.5, size = 10),
  Binomial$new()))
p$pdf(1:5)
p$pdf(1, 2)
p$pdf(1:2)
```

Method \texttt{cdf()}: Cumulative distribution function of the product distribution. Computed by

\[ F_P(X_1 = x_1, ..., X_N = x_N) = \prod_i F_{X_i}(x_i) \]

where \( F_{X_i} \) are the cdfs of the wrapped distributions.

Usage:

```r
ProductDistribution$cdf(
  ..., 
  lower.tail = TRUE, 
  log.p = FALSE, 
  simplify = TRUE, 
  data = NULL 
)
```

Arguments:

\( ... \) (numeric())

Points to evaluate the function at. Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

lower.tail (logical(1))

If \( \text{TRUE} \) (default), probabilities are \( X \leq x \), otherwise, \( P(X > x) \).

log.p (logical(1))

If \( \text{TRUE} \) returns the logarithm of the probabilities. Default is \( \text{FALSE} \).

simplify logical(1)

If \( \text{TRUE} \) (default) simplifies the return if possible to a numeric, otherwise returns a \texttt{data.table::data.table}.

data array

Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of \texttt{VectorDistributions} of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

Examples:

```r
p <- ProductDistribution$new(list(
  Binomial$new(prob = 0.5, size = 10),
  Binomial$new()))
p$cdf(1:5)
p$cdf(1, 2)
p$cdf(1:2)
```

Method \texttt{quantile()}: The quantile function is not implemented for product distributions.
Usage:
ProductDistribution$quantile(
  ..., 
  lower.tail = TRUE, 
  log.p = FALSE, 
  simplify = TRUE, 
  data = NULL
)

Arguments:
... (numeric())
  Points to evaluate the function at Arguments do not need to be named. The length of each
  argument corresponds to the number of points to evaluate, the number of arguments cor-
  sponds to the number of variables in the distribution. See examples.
lower.tail (logical(1))
  If TRUE (default), probabilities are $X \leq x$, otherwise, $P(X > x)$.
log.p (logical(1))
  If TRUE returns the logarithm of the probabilities. Default is FALSE.
simplify logical(1)
  If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.
data array
  Alternative method to specify points to evaluate. If univariate then rows correspond with
  number of points to evaluate and columns correspond with number of variables to eval-
  uate. In the special case of VectorDistributions of multivariate distributions, then the third
  dimension corresponds to the distribution in the vector to evaluate.

Method clone(): The objects of this class are cloneable with this method.

Usage:
ProductDistribution$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

See Also

Other wrappers: Convolution, DistributionWrapper, HuberizedDistribution, MixtureDistribution,
TruncatedDistribution, VectorDistribution

Examples

```r
## Not run:
ProductDistribution$new(list(Binomial$new(
  prob = 0.5, 
  size = 10
), Normal$new(mean = 15)))
```
ProductDistribution$new(
  distribution = "Binomial",
  params = list(
    list(prob = 0.1, size = 2),
    list(prob = 0.6, size = 4),
    list(prob = 0.2, size = 6)
  )
)

# Equivalently
ProductDistribution$new(
  distribution = "Binomial",
  params = data.table::data.table(prob = c(0.1, 0.6, 0.2), size = c(2, 4, 6))
)

## End(Not run)

## Method `ProductDistribution$pdf`

p <- ProductDistribution$new(list(
  Binomial$new(prob = 0.5, size = 10),
  Binomial$new()OUGH
)
p$pdf(1:5)
p$pdf(1, 2)
p$pdf(1:2)

## Method `ProductDistribution$cdf`

p <- ProductDistribution$new(list(
  Binomial$new(prob = 0.5, size = 10),
  Binomial$new()OUGH
)
p$cdf(1:5)
p$cdf(1, 2)
p$cdf(1:2)

Normal$new() * Binomial$new()

---

**properties**

**Properties Accessor**

### Description

Returns the properties of the distribution.

### Usage

`properties(object)`
Arguments

object Distribution.

Value

List of distribution properties.

R6 Usage

R$properties

qqplot

Quantile-Quantile Plots for distr6 Objects

Description

Quantile-quantile plots are used to compare a "theoretical" or empirical distribution to a reference distribution. They can also compare the quantiles of two reference distributions.

Usage

qqplot(x, y, npoints = 3000, idline = TRUE, plot = TRUE, ...)

Arguments

x distr6 object or numeric vector.
y distr6 object or numeric vector.
npoints number of evaluation points.
idline logical; if TRUE (default), the line \( y = x \) is plotted
plot logical; if TRUE (default), figures are displayed in the plot window; otherwise a data.table::data.table of points and calculated values is returned.
... graphical parameters.

Details

If \( x \) or \( y \) are given as numeric vectors then they are first passed to the Empirical distribution. The Empirical distribution is a discrete distribution so quantiles are equivalent to the the Type 1 method in quantile.

Author(s)

Chijing Zeng

See Also

plot.Distribution for plotting a distr6 object.
Examples

```r
qqplot(Normal$new(mean = 15, sd = sqrt(30)), ChiSquared$new(df = 15))
qqplot(rt(200, df = 5), rt(300, df = 5),
    main = "QQ-Plot", xlab = "t-200",
    ylab = "t-300"
)
qqplot(Normal$new(mean = 2), rnorm(100, mean = 3))
```

quantile.Distribution *Inverse Cumulative Distribution Function*

Description

See `Distribution$quantile`

Usage

```r
## S3 method for class 'Distribution'
quantile(
  x, ...
  lower.tail = TRUE,
  log.p = FALSE,
  simplify = TRUE,
  data = NULL
)
```

Arguments

- `x` *(Distribution)*
- `...` *(numeric())*
  Points to evaluate the quantile function of the distribution. Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.
- `lower.tail` logical(1)
  If TRUE (default), probabilities are $X \leq x$, otherwise, $X > x$.
- `log.p` logical(1)
  If TRUE returns log-cdf. Default is FALSE.
- `simplify` logical(1)
  If TRUE (default) simplifies the pdf if possible to a numeric, otherwise returns a `data.table::data.table`.
- `data` array
  Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of `VectorDistributions` of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.
Value

Quantile evaluated at given points as either a numeric if `simplify` is TRUE or as a `data.table::data.table`.

Quartic Kernel

Description

Mathematical and statistical functions for the Quartic kernel defined by the pdf,

\[ f(x) = \frac{15}{16}(1 - x^2)^2 \]

over the support \( x \in (-1, 1) \).

Details

Quantile is omitted as no closed form analytic expression could be found, decorate with Function-Imputation for numeric results.

Super classes

```
distr6::Distribution -> distr6::Kernel -> Quartic
```

Public fields

- name: Full name of distribution.
- short_name: Short name of distribution for printing.
- description: Brief description of the distribution.

Methods

Public methods:

- `Quartic$pdfSquared2Norm()`
- `Quartic$cdfSquared2Norm()`
- `Quartic$variance()`
- `Quartic$clone()`

Method `pdfSquared2Norm()`: The squared 2-norm of the pdf is defined by

\[ \int_a^b (f_X(u))^2 du \]

where \( X \) is the Distribution, \( f_X \) is its pdf and \( a, b \) are the distribution support limits.

Usage:

```
Quartic$pdfSquared2Norm(x = 0, upper = Inf)
```

Arguments:
Method cdfSquared2Norm(): The squared 2-norm of the cdf is defined by
\[ \int_a^b (F_X(u))^2 du \]
where X is the Distribution, \( F_X \) is its pdf and \( a, b \) are the distribution support limits.

Usage:
Quartic$cdfSquared2Norm(x = 0, upper = 0)

Arguments:
- x (numeric(1))
  Amount to shift the result.
- upper (numeric(1))
  Upper limit of the integral.

Method variance(): The variance of a distribution is defined by the formula
\[ var_X = E[X^2] - E[X]^2 \]
where \( E_X \) is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

Usage:
Quartic$variance(...)  
Arguments:
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Quartic$clone(deep = FALSE)

Arguments:
- deep Whether to make a deep clone.

See Also
Other kernels: Cosine, Epanechnikov, LogisticKernel, NormalKernel, Sigmoid, Silverman, TriangularKernel, Tricube, Triweight, UniformKernel
rand  

Random Simulation Function

Description

See Distribution$rand

Usage

rand(object, n, simplify = TRUE)

Arguments

object  

(Distribution)

n  

(numeric(1))

Number of points to simulate from the distribution. If length greater than 1, then 
n <- length(n).

simplify  

logical(1)

If TRUE (default) simplifies the pdf if possible to a numeric, otherwise returns a  
data.table::data.table.

Value

Simulations as either a numeric if simplify is TRUE or as a data.table::data.table.

Rayleigh

Rayleigh Distribution Class

Description

Mathematical and statistical functions for the Rayleigh distribution, which is commonly used to  
model random complex numbers..

Details

The Rayleigh distribution parameterised with mode (or scale), $\alpha$, is defined by the pdf,  

$$f(x) = \frac{x}{\alpha^2} \exp\left(-\frac{x^2}{2\alpha^2}\right)$$

for $\alpha > 0$.

Value

Returns an R6 object inheriting from class SDistribution.
**Distribution support**

The distribution is supported on $[0, \infty)$.

**Default Parameterisation**

Rayl(mode = 1)

**Omitted Methods**

N/A

**Also known as**

N/A

**Super classes**

\[ \text{distr6::Distribution} \rightarrow \text{distr6::SDistribution} \rightarrow \text{Rayleigh} \]

**Public fields**

- name: Full name of distribution.
- short_name: Short name of distribution for printing.
- description: Brief description of the distribution.
- packages: Packages required to be installed in order to construct the distribution.

**Methods**

**Public methods:**

- Rayleigh$new()
- Rayleigh$mean()
- Rayleigh$mode()
- Rayleigh$median()
- Rayleigh$variance()
- Rayleigh$skewness()
- Rayleigh$kurtosis()
- Rayleigh$entropy()
- Rayleigh$pgf()
- Rayleigh$clone()

**Method** new(): Creates a new instance of this R6 class.

**Usage:**

Rayleigh$new(mode = NULL, decorators = NULL)

**Arguments:**

- mode (numeric(1))
  
  Mode of the distribution, defined on the positive Reals. Scale parameter.
decorators (character())
Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

$$E_X(X) = \sum p_X(x) \cdot x$$

with an integration analogue for continuous distributions.

Usage:
Rayleigh$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Rayleigh$mode(which = "all")

Arguments:
which (character(1) | numeric(1)
Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method median(): Returns the median of the distribution. If an analytical expression is available returns distribution median, otherwise if symmetric returns self$mean, otherwise returns self$quantile(0.5).

Usage:
Rayleigh$median()

Method variance(): The variance of a distribution is defined by the formula

$$var_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution $X$. If the distribution is multivariate the covariance matrix is returned.

Usage:
Rayleigh$variance(...)

Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

$$sk_X = E_X\left[\frac{x - \mu^3}{\sigma}\right]$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution.

Usage:
Rayleigh$skewness(...)
Arguments:
... Unused.

**Method** kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,
\[
k_X = E_X\left[\frac{x - \mu}{\sigma}^4\right]
\]
where \( E_X \) is the expectation of distribution X, \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

**Usage:**
Rayleigh$kurtosis(excess = TRUE, ...)
Arguments:
excess (logical(1))
If TRUE (default) excess kurtosis returned.
... Unused.

**Method** entropy(): The entropy of a (discrete) distribution is defined by
\[
-\sum(f_X)\log(f_X)
\]
where \( f_X \) is the pdf of distribution X, with an integration analogue for continuous distributions.

**Usage:**
Rayleigh$entropy(base = 2, ...)
Arguments:
base (integer(1))
Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

**Method** pgf(): The probability generating function is defined by
\[
pgf_X(z) = E_X[\exp(z^X)]
\]
where X is the distribution and \( E_X \) is the expectation of the distribution X.

**Usage:**
Rayleigh$pgf(z, ...)
Arguments:
z (integer(1))
z integer to evaluate probability generating function at.
... Unused.

**Method** clone(): The objects of this class are cloneable with this method.

**Usage:**
Rayleigh$clone(deep = FALSE)
Arguments:
deep Whether to make a deep clone.
References


See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

---

**rep.Distribution**  
Replicate Distribution into Vector, Mixture, or Product

**Description**

Replicates a constructed distribution into either a

- VectorDistribution (class = "vector")
- ProductDistribution (class = "product")
- MixtureDistribution (class = "mixture")

If the distribution is not a custom Distribution then uses the more efficient distribution/params constructor, otherwise uses distlist.

**Usage**

```r
## S3 method for class 'Distribution'
rep(x, times, class = c("vector", "product", "mixture"), ...)
```

**Arguments**

- `x`  
  Distribution

- `times`  
  (integer(1)) Number of times to replicate the distribution

- `class`  
  (character(1)) What type of vector to create, see description.

- `...`  
  Additional arguments, currently unused.
Examples

```r
rep(Binomial$new(), 10)
rep(Gamma$new(), 2, class = "product")
```

---

**SDistribution**

**Abstract Special Distribution Class**

**Description**

Abstract class that cannot be constructed directly.

**Value**

Returns error. Abstract classes cannot be constructed directly.

**Super class**

`distr6::Distribution` -> `SDistribution`

**Public fields**

- `package`  Deprecated, use `$packages` instead.
- `packages`  Packages required to be installed in order to construct the distribution.

**Methods**

**Public methods:**

- `SDistribution$new()`
- `SDistribution$clone()`

**Method `new()`:** Creates a new instance of this `R6` class.

**Usage:**

```r
SDistribution$new(
  decorators,
  support,
  type,
  symmetry = c("asymmetric", "symmetric")
)
```

**Arguments:**

- `decorators`  (character())
  - Decorators to add to the distribution during construction.
- `support`  [set6::Set]
  - Support of the distribution.
- `type`  [set6::Set]
  - Type of the distribution.
setParameterValue

**symmetry character(1)**

Distribution symmetry type, default "asymmetric".

**Method clone():** The objects of this class are cloneable with this method.

*Usage:*

`SDistribution$clone(deep = FALSE)`

*Arguments:*

- `deep` Whether to make a deep clone.

---

**setParameterValue Parameter Value Setter**

**Description**

Sets the value of the given parameter.

**Usage**

`setParameterValue(object, ..., lst = NULL, error = "warn", resolveConflicts = FALSE)`

**Arguments**

- `object` Distribution or ParameterSet.
- `...` named parameters and values to update, see details.
- `lst` optional list, see details.
- `error` character, value to pass to `stopwarn`.
- `resolveConflicts` (logical(1))

If FALSE (default) throws error if conflicting parameterisations are provided, otherwise automatically resolves them by removing all conflicting parameters.

**Value**

An R6 object of class ParameterSet.
Description

Mathematical and statistical functions for the Shifted Log-Logistic distribution, which is commonly used in survival analysis for its non-monotonic hazard as well as in economics, a generalised variant of Loglogistic.

Details

The Shifted Log-Logistic distribution parameterised with shape, \( \beta \), scale, \( \alpha \), and location, \( \gamma \), is defined by the pdf,

\[
f(x) = \left( \frac{\beta}{\alpha} \right) \left( \frac{(x - \gamma)}{\alpha} \right)^{\beta - 1} \left( 1 + \left( \frac{(x - \gamma)}{\alpha} \right)^\beta \right)^{-2}
\]

for \( \alpha, \beta > 0 \) and \( \gamma \geq 0 \).

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on the non-negative Reals.

Default Parameterisation

ShiftLLogis(scale = 1, shape = 1, location = 0)

Omitted Methods

N/A

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> ShiftedLoglogistic

Public fields

name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.
Methods

Public methods:
- `ShiftedLoglogistic$new()`
- `ShiftedLoglogistic$mean()`
- `ShiftedLoglogistic$mode()`
- `ShiftedLoglogistic$median()`
- `ShiftedLoglogistic$variance()`
- `ShiftedLoglogistic$pgf()`
- `ShiftedLoglogistic$setParameterValue()`
- `ShiftedLoglogistic$clone()`

Method `new()`: Creates a new instance of this R6 class.

Usage:
```r
ShiftedLoglogistic$new(
  scale = NULL,
  shape = NULL,
  location = NULL,
  rate = NULL,
  decorators = NULL
)
```

Arguments:
- `scale` (numeric(1))
  Scale parameter of the distribution, defined on the positive Reals. `scale = 1/rate`. If provided `rate` is ignored.
- `shape` (numeric(1))
  Shape parameter, defined on the positive Reals.
- `location` (numeric(1))
  Location parameter, defined on the Reals.
- `rate` (numeric(1))
  Rate parameter of the distribution, defined on the positive Reals.
- `decorators` (character())
  Decorators to add to the distribution during construction.

Method `mean()`: The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

$$E_X(X) = \sum p_X(x) \ast x$$

with an integration analogue for continuous distributions.

Usage:
```r
ShiftedLoglogistic$mean(...)```

Arguments:
- `...` Unused.

Method `mode()`: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).
**Usage:**
`ShiftedLoglogistic$mode(which = "all")`

**Arguments:**
which (character(1) | numeric(1))
> Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

**Method median():** Returns the median of the distribution. If an analytical expression is available returns distribution median, otherwise if symmetric returns self$mean, otherwise returns self$quantile(0.5).

**Usage:**
`ShiftedLoglogistic$median()`

**Method variance():** The variance of a distribution is defined by the formula

\[ var_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

**Usage:**
`ShiftedLoglogistic$variance(...)`

**Arguments:**
... Unused.

**Method pgf():** The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(z^x)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

**Usage:**
`ShiftedLoglogistic$pgf(z, ...)`

**Arguments:**

**Method setParameterValue():** Sets the value(s) of the given parameter(s).

**Usage:**
`ShiftedLoglogistic$setParameterValue(..., lst = NULL, error = "warn", resolveConflicts = FALSE)`

**Arguments:**


Sigmoid

... ANY

Named arguments of parameters to set values for. See examples.

1st (list(1))

Alternative argument for passing parameters. List names should be parameter names and
list values are the new values to set.

error (character(1))

If "warn" then returns a warning on error, otherwise breaks if "stop".

resolveConflicts (logical(1))

If FALSE (default) throws error if conflicting parameterisations are provided, otherwise au-
tomatically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
ShiftedLoglogistic$clone(deep = FALSE)

Arguments:

deep Whether to make a deep clone.

References

Michael P. McLaughlin.

See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral,
ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution,
Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal,
MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, StudentTNoncentral, StudentT,
Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical,
Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang,
Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz,
Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal,
NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, StudentTNoncentral, StudentT, Triangular,
Uniform, Wald, Weibull, WeightedDiscrete

---

Sigmoid

Sigmoid Kernel

Description

Mathematical and statistical functions for the Sigmoid kernel defined by the pdf,

\[ f(x) = \frac{2}{\pi} \frac{\exp(x) + \exp(-x)}{\exp(x) + \exp(-x)} \]

over the support \( x \in R \).
Details

The cdf and quantile functions are omitted as no closed form analytic expressions could be found, decorate with FunctionImputation for numeric results.

Super classes

distr6::Distribution -> distr6::Kernel -> Sigmoid

Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.

Methods

Public methods:

- Sigmoid$new()
- Sigmoid$pdfSquared2Norm()
- Sigmoid$variance()
- Sigmoid$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Sigmoid$new(decorators = NULL)

Arguments:

decorators (character())

Decorators to add to the distribution during construction.

Method pdfSquared2Norm(): The squared 2-norm of the pdf is defined by

$$\int_a^b (f_X(u))^2 du$$

where X is the Distribution, $f_X$ is its pdf and $a, b$ are the distribution support limits.

Usage:
Sigmoid$pdfSquared2Norm(x = 0, upper = Inf)

Arguments:

x (numeric(1))
  Amount to shift the result.
upper (numeric(1))
  Upper limit of the integral.

Method variance(): The variance of a distribution is defined by the formula

$$var_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.
Usage:
Sigmoid$variance(...)

Arguments:
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Sigmoid$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

See Also

Other kernels: Cosine, Epanechnikov, LogisticKernel, NormalKernel, Quartic, Silverman, TriangularKernel, Tricube, Triweight, UniformKernel

---

Silverman Silverman Kernel

Description

Mathematical and statistical functions for the Silverman kernel defined by the pdf,

\[ f(x) = \frac{\exp(-|x|/\sqrt{2})/2 \cdot \sin(|x|/\sqrt{2} + \pi/4)}{2} \]

over the support \( x \in \mathbb{R} \).

Details

The cdf and quantile functions are omitted as no closed form analytic expressions could be found, decorate with FunctionImputation for numeric results.

Super classes

distr6::Distribution -> distr6::Kernel -> Silverman

Public fields

name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
Methods

Public methods:

- Silverman$new()
- Silverman$pdfSquared2Norm()
- Silverman$cdfSquared2Norm()
- Silverman$variance()
- Silverman$clone()

**Method new()**: Creates a new instance of this R6 class.

**Usage**:
Silverman$new(decorators = NULL)

**Arguments**:
- decorators (character())
  Decorators to add to the distribution during construction.

**Method pdfSquared2Norm()**: The squared 2-norm of the pdf is defined by

\[
\int_a^b (f_X(u))^2 du
\]

where X is the Distribution, \( f_X \) is its pdf and \( a, b \) are the distribution support limits.

**Usage**:
Silverman$pdfSquared2Norm(x = 0, upper = Inf)

**Arguments**:
- x (numeric(1))
  Amount to shift the result.
- upper (numeric(1))
  Upper limit of the integral.

**Method cdfSquared2Norm()**: The squared 2-norm of the cdf is defined by

\[
\int_a^b (F_X(u))^2 du
\]

where X is the Distribution, \( F_X \) is its pdf and \( a, b \) are the distribution support limits.

**Usage**:
Silverman$cdfSquared2Norm(x = 0, upper = 0)

**Arguments**:
- x (numeric(1))
  Amount to shift the result.
- upper (numeric(1))
  Upper limit of the integral.
Method variance(): The variance of a distribution is defined by the formula

$$\text{var}_{X} = \mathbb{E}[X^2] - \mathbb{E}[X]^2$$

where $\mathbb{E}_X$ is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

Usage:
Silverman$variance(\ldots)

Arguments:
\ldots Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Silverman$clone(deep = FALSE)

Arguments:
depth Whether to make a deep clone.

See Also

Other kernels: Cosine, Epanechnikov, LogisticKernel, NormalKernel, Quartic, Sigmoid, TriangularKernel, Tricube, Triweight, UniformKernel

simulateEmpiricalDistribution

Sample Empirical Distribution Without Replacement

Description

Function to sample Empirical Distributions without replacement, as opposed to the rand method which samples with replacement.

Usage

simulateEmpiricalDistribution(EmpiricalDist, n, seed = NULL)

Arguments

EmpiricalDist  Empirical Distribution
n             Number of samples to generate. See Details.
seed          Numeric passed to set.seed. See Details.
Details

This function can only be used to sample from the **Empirical** distribution without replacement, and will return an error for other distributions.

The seed param ensures that the same samples can be reproduced and is more convenient than using the `set.seed()` function each time before use. If `set.seed` is `NULL` then the seed is left unchanged (`NULL` is not passed to the `set.seed` function).

If `n` is of length greater than one, then `n` is taken to be the length of `n`. If `n` is greater than the number of observations in the Empirical distribution, then `n` is taken to be the number of observations in the distribution.

Value

A vector of length `n` with elements drawn without replacement from the given Empirical distribution.

**skewness**                  *Distribution Skewness*

Description

Skewness of a distribution

Usage

`skewness(object, ...)`

Arguments

- `object` Distribution.
- `...` Passed to `$genExp`.

Value

Skewness as a numeric.
skewnessType

*Type of Skewness Accessor - Deprecated*

**Description**

Deprecated. Use $properties$skewness.

**Usage**

skewnessType(object)

**Arguments**

object Distribution.

**Value**

If the distribution skewness is present in properties, returns one of "negative skew", "no skew", "positive skew", otherwise returns NULL.

---

skewType

*Skewness Type*

**Description**

Gets the type of skewness

**Usage**

skewType(skew)

**Arguments**

skew numeric.

**Details**

Skewness is a measure of asymmetry of a distribution.

A distribution can either have negative skew, no skew or positive skew. A symmetric distribution will always have no skew but the reverse relationship does not always hold.

**Value**

Returns one of 'negative skew', 'no skew' or 'positive skew'.
See Also

skewness, exkurtosisType

Examples

skewType(1)
skewType(0)
skewType(-1)

---

stdev

Standard Deviation of a Distribution

Description

Standard deviation of a distribution assuming variance is provided.

Usage

stdev(object)

Arguments

object Distribution.

Value

Square-root of variance as a numeric.

---

strprint

String Representation of Print

Description

Parsable string to be supplied to print, data.frame, etc.

Usage

strprint(object, n = 2)

Arguments

object R6 object
n Number of parameters to display before & after ellipsis
Details

strprint is a suggested method that should be included in all R6 classes to be passed to methods such as cat, summary and print. Additionally can be used to easily parse R6 objects into data-frames, see examples.

Value

String representation of the distribution.

Examples

```r
Triangular$new()$strprint()
Triangular$new()$strprint(1)
```
StudentT

Also known as
N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> StudentT

Public fields

name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.

Methods

Public methods:
• StudentT$new()
• StudentT$mean()
• StudentT$mode()
• StudentT$variance()
• StudentT$skewness()
• StudentT$kurtosis()
• StudentT$entropy()
• StudentT$mgf()
• StudentT$cf()
• StudentT$pgf()
• StudentT$clone()

Method new(): Creates a new instance of this R6 class.
Usage:
StudentT$new(df = NULL, decorators = NULL)
Arguments:
df (integer(1))
  Degrees of freedom of the distribution defined on the positive Reals.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

$$E_X(X) = \sum p_X(x) \cdot x$$

with an integration analogue for continuous distributions.
Usage:
StudentT$mean(...)
Method `mode()`: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
```r
StudentT$mode(which = "all")
```
Arguments:
which (character(1) | numeric(1))
Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method `variance()`: The variance of a distribution is defined by the formula

\[
\text{var}_X = E[X^2] - E[X]^2
\]

where \(E_X\) is the expectation of distribution \(X\). If the distribution is multivariate the covariance matrix is returned.

Usage:
```r
StudentT$variance(...)```
Arguments:
... Unused.

Method `skewness()`: The skewness of a distribution is defined by the third standardised moment,

\[
\text{sk}_X = E_X\left[\frac{x - \mu}{\sigma}\right]^3
\]

where \(E_X\) is the expectation of distribution \(X\), \(\mu\) is the mean of the distribution and \(\sigma\) is the standard deviation of the distribution.

Usage:
```r
StudentT$skewness(...)```
Arguments:
... Unused.

Method `kurtosis()`: The kurtosis of a distribution is defined by the fourth standardised moment,

\[
\text{k}_X = E_X\left[\frac{x - \mu}{\sigma}\right]^4
\]

where \(E_X\) is the expectation of distribution \(X\), \(\mu\) is the mean of the distribution and \(\sigma\) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
```r
StudentT$kurtosis(excess = TRUE, ...)```
Arguments:
excess (logical(1))
If TRUE (default) excess kurtosis returned.
Method `entropy()`: The entropy of a (discrete) distribution is defined by

\[- \sum (f_X) \log(f_X)\]

where \(f_X\) is the pdf of distribution \(X\), with an integration analogue for continuous distributions.

Usage:

```r
StudentT$entropy(base = 2, ...)
```

Arguments:

- `base` (integer(1))
  - Base of the entropy logarithm, default = 2 (Shannon entropy)
  - Unused.

Method `mgf()`: The moment generating function is defined by

\[mgf_X(t) = E_X[exp(xt)]\]

where \(X\) is the distribution and \(E_X\) is the expectation of the distribution \(X\).

Usage:

```r
StudentT$mgf(t, ...)
```

Arguments:

- `t` (integer(1))
  - \(t\) integer to evaluate function at.
  - Unused.

Method `cf()`: The characteristic function is defined by

\[cf_X(t) = E_X[exp(xti)]\]

where \(X\) is the distribution and \(E_X\) is the expectation of the distribution \(X\).

Usage:

```r
StudentT$cf(t, ...)
```

Arguments:

- `t` (integer(1))
  - \(t\) integer to evaluate function at.
  - Unused.

Method `pgf()`: The probability generating function is defined by

\[pgf_X(z) = E_X[exp(z^x)]\]

where \(X\) is the distribution and \(E_X\) is the expectation of the distribution \(X\).

Usage:

```r
StudentT$pgf(z, ...)
```

Arguments:
Method \texttt{clone()}: The objects of this class are cloneable with this method.

Usage:
\texttt{StudentT$\text{clone}(deep = FALSE)}

Arguments:
\texttt{deep} Whether to make a deep clone.

Author(s)
Chijing Zeng

References

See Also
Other continuous distributions: \texttt{Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, Triangular, Uniform, Wald, Weibull}

Other univariate distributions: \texttt{Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, Triangular, Uniform, Wald, Weibull, WeightedDiscrete}
Details

The Noncentral Student’s T distribution parameterised with degrees of freedom, \( \nu \) and location, \( \lambda \), is defined by the pdf,

\[
f(x) = \left( \frac{\nu^{\nu/2} \exp\left(-\left(\nu \lambda^2\right)/(2(x^2+\nu))\right)}{\sqrt{\pi} \Gamma(\nu/2) 2^{(\nu-1)/2} (x^2+\nu)^{(\nu+1)/2}} \right) \int_0^\infty y^{\nu/2} \exp\left(-\frac{1}{2} (y-x\lambda/\sqrt{x^2+\nu})^2\right) dy
\]

for \( \nu > 0 \), \( \lambda \in \mathbb{R} \).

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on the Reals.

Default Parameterisation

\( \text{TNS}(df = 1, \text{location} = 0) \)

Omitted Methods

N/A

Also known as

N/A

Super classes

\[ \text{distr6::Distribution} \rightarrow \text{distr6::SDistribution} \rightarrow \text{StudentTNoncentral} \]

Public fields

- name Full name of distribution.
- short_name Short name of distribution for printing.
- description Brief description of the distribution.
- packages Packages required to be installed in order to construct the distribution.

Methods

Public methods:

- \text{StudentTNoncentral}\$new()
- \text{StudentTNoncentral}\$mean()
- \text{StudentTNoncentral}\$variance()
- \text{StudentTNoncentral}\$clone()

Method \text{new}(): Creates a new instance of this R6 class.
Usage:
StudentTNoncentral$new(df = NULL, location = NULL, decorators = NULL)

Arguments:
df (integer(1))
   Degrees of freedom of the distribution defined on the positive Reals.
location (numeric(1))
   Location parameter, defined on the Reals.
decorators (character())
   Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution \( X \) is the expectation

\[
E_X(X) = \sum p_X(x) \cdot x
\]

with an integration analogue for continuous distributions.

Usage:
StudentTNoncentral$mean(...)

Arguments:
... Unused.

Method variance(): The variance of a distribution is defined by the formula

\[
var_X = E[X^2] - E[X]^2
\]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
StudentTNoncentral$variance(...)

Arguments:
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
StudentTNoncentral$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

Author(s)
Jordan Deenichin

References
summary.Distribution

See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentT, Triangular, Uniform, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentT, Triangular, Uniform, Wald, Weibull, WeightedDiscrete

---

**summary.Distribution**

**Distribution Summary**

**Description**

Summary method for distribution objects (and all child classes).

**Usage**

```r
## S3 method for class 'Distribution'
summary(object, full = TRUE, ...)
```

**Arguments**

- `object` Distribution.
- `full` logical; if TRUE (default), gives an extended summary, otherwise brief.
- `...` additional arguments.

**Value**

Printed summary of the distribution.

**R6 Usage**

```r
$summary(full = TRUE)
```

**See Also**

Distribution
**Supremum Accessor**

**Description**
Returns the distribution supremum as the supremum of the support.

**Usage**
sup(object)

**Arguments**
object Distribution.

**Value**
Supremum as a numeric.

**R6 Usage**
$sup$

---

**Support Accessor - Deprecated**

**Description**
Deprecated. Use $properties$support

**Usage**
support(object)

**Arguments**
object Distribution.

**Details**
The support of a probability distribution is defined as the interval where the pmf/pdf is greater than zero,

\[ Supp(X) = \{ x \in R : f_X(x) > 0 \} \]

where \( f_X \) is the pmf if distribution \( X \) is discrete, otherwise the pdf.
survival

Value
An R6 object of class set6::Set.

R6 Usage
$support

survival  Survival Function

Description
See ExoticStatistics$survival.

Usage
survival(object, ..., log = FALSE, simplify = TRUE, data = NULL)

Arguments
object (Distribution).
... (numeric())
Points to evaluate the probability density function of the distribution. Arguments
do not need to be named. The length of each argument corresponds to the num-
ber of points to evaluate, the number of arguments corresponds to the number of
variables in the distribution. See examples.
log logical(1)
If TRUE returns log-Hazard Default is FALSE.
simplify logical(1)
If TRUE (default) simplifies the pdf if possible to a numeric, otherwise returns a
data.table::data.table.
data array
Alternative method to specify points to evaluate. If univariate then rows corre-
spond with number of points to evaluate and columns correspond with number
of variables to evaluate. In the special case of VectorDistributions of multivari-
ate distributions, then the third dimension corresponds to the distribution in the
vector to evaluate.

Value
Survival function as a numeric, natural logarithm returned if log is TRUE.
survivalAntiDeriv  

**Survival Function Anti-Derivative**

**Description**

The anti-derivative of the survival function between given limits or over the full support.

**Usage**

```r
survivalAntiDeriv(object, lower = NULL, upper = NULL)
```

**Arguments**

- `object` : Distribution.
- `lower` : lower limit for integration, default is infimum.
- `upper` : upper limit for integration, default is supremum.

**Value**

Antiderivative of the survival function evaluated between limits as a numeric.

---

survivalPNorm  

**Survival Function P-Norm**

**Description**

The p-norm of the survival function evaluated between given limits or over the whole support.

**Usage**

```r
survivalPNorm(object, p = 2, lower = NULL, upper = NULL)
```

**Arguments**

- `object` : Distribution.
- `p` : p-norm to calculate.
- `lower` : lower limit for integration, default is infimum.
- `upper` : upper limit for integration, default is supremum.

**Value**

Given p-norm of survival function evaluated between limits as a numeric.
**symmetry**

*Symmetry Accessor - Deprecated*

**Description**

Deprecated. Use $\text{properties}\$symmetry.

**Usage**

 symmetry(object)

**Arguments**

 object Distribution.

**Value**

One of "symmetric" or "asymmetric".

**testContinuous**  \[ assert/check/test/Continuous \]

**Description**

Validation checks to test if Distribution is continuous.

**Usage**

 testContinuous(
  object,
  errmsg = paste(object$short_name, "is not continuous")
 )

 checkContinuous(
  object,
  errmsg = paste(object$short_name, "is not continuous")
 )

 assertContinuous(
  object,
  errmsg = paste(object$short_name, "is not continuous")
 )

**Arguments**

 object Distribution

 errmsg custom error message to return if assert/check fails
Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

testDiscrete(Binomial$new()) # FALSE

Description

Validation checks to test if Distribution is discrete.

Usage

testDiscrete(object, errmsg = paste(object$short_name, "is not discrete"))
checkDiscrete(object, errmsg = paste(object$short_name, "is not discrete"))
assertDiscrete(object, errmsg = paste(object$short_name, "is not discrete"))

Arguments

oobject Distribution
errmsg custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

testDiscrete(Binomial$new()) # FALSE
**Description**

Validation checks to test if a given object is a **Distribution**.

**Usage**

```r
testDistribution(
  object,
  errormsg = paste(object, "is not an R6 Distribution object")
)
```

```r
checkDistribution(
  object,
  errormsg = paste(object, "is not an R6 Distribution object")
)
```

```r
assertDistribution(
  object,
  errormsg = paste(object, "is not an R6 Distribution object")
)
```

**Arguments**

- `object` object to test
- `errormsg` custom error message to return if assert/check fails

**Value**

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

**Examples**

```r
testDistribution(5) # FALSE
testDistribution(Binomial$new()) # TRUE
```
Description

Validation checks to test if a given object is a list of Distributions.

Usage

```r
testDistributionList(
  object,
  errormsg = "One or more items in the list are not Distributions"
)
```

```r
checkDistributionList(
  object,
  errormsg = "One or more items in the list are not Distributions"
)
```

```r
assertDistributionList(
  object,
  errormsg = "One or more items in the list are not Distributions"
)
```

Arguments

- `object` object to test
- `errormsg` custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

```r
testDistributionList(list(Binomial$new(), 5)) # FALSE
testDistributionList(list(Binomial$new(), Exponential$new())) # TRUE
```
testLeptokurtic

Description

Validation checks to test if Distribution is leptokurtic.

Usage

testLeptokurtic(
  object,
  errormsg = paste(object$short_name, "is not leptokurtic")
)

checkLeptokurtic(
  object,
  errormsg = paste(object$short_name, "is not leptokurtic")
)

assertLeptokurtic(
  object,
  errormsg = paste(object$short_name, "is not leptokurtic")
)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>object</td>
<td>Distribution</td>
</tr>
<tr>
<td>errmsg</td>
<td>custom error message to return if assert/check fails</td>
</tr>
</tbody>
</table>

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

```r
  testLeptokurtic(Binomial$new())
```
testMatrixvariate    assert/check/test/Matrixvariate

Description

Validation checks to test if Distribution is matrixvariate.

Usage

testMatrixvariate(
  object,
  errormsg = paste(object$short_name, "is not matrixvariate")
)

checkMatrixvariate(
  object,
  errormsg = paste(object$short_name, "is not matrixvariate")
)

assertMatrixvariate(
  object,
  errormsg = paste(object$short_name, "is not matrixvariate")
)

Arguments

object    Distribution
errormsg  custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

testMatrixvariate(Binomial$new()) # FALSE
Description

Validation checks to test if Distribution is mesokurtic.

Usage

testMesokurtic(
  object,
  errmsg = paste(object$short_name, "is not mesokurtic")
)

checkMesokurtic(
  object,
  errmsg = paste(object$short_name, "is not mesokurtic")
)

assertMesokurtic(
  object,
  errmsg = paste(object$short_name, "is not mesokurtic")
)

Arguments

object Distribution
errmsg custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

testMesokurtic(Binomial$new())
Description

Validation checks to test if Distribution is mixture.

Usage

testMixture(object, errormsg = paste(object$short_name, "is not mixture"))
checkMixture(object, errormsg = paste(object$short_name, "is not mixture"))
assertMixture(object, errormsg = paste(object$short_name, "is not mixture"))

Arguments

object Distribution
errormsg custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

testMixture(Binomial$new()) # FALSE

testMultivariate

Description

Validation checks to test if Distribution is multivariate.

Usage

testMultivariate(  
  object,  
  errormsg = paste(object$short_name, "is not multivariate")  
)
checkMultivariate(  
  object,  
  errormsg = paste(object$short_name, "is not multivariate")  
)
testNegativeSkew

)  

assertMultivariate(
    object,
    errormsg = paste(object$short_name, "is not multivariate")
)

Arguments

object           Distribution  
errormsg         custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert 
stops code with error, check returns an error message as string, test returns FALSE.

Examples

testMultivariate(Binomial$new()) # FALSE

__________________________________________________________________________

testNegativeSkew   assert/check/test/NegativeSkew

Description

Validation checks to test if Distribution is negative skew.

Usage

testNegativeSkew(
    object,
    errormsg = paste(object$short_name, "is not negative skew")
)

checkNegativeSkew(
    object,
    errormsg = paste(object$short_name, "is not negative skew")
)

assertNegativeSkew(
    object,
    errormsg = paste(object$short_name, "is not negative skew")
)
**Arguments**

<table>
<thead>
<tr>
<th>object</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>errormsg</td>
<td>custom error message to return if assert/check fails</td>
</tr>
</tbody>
</table>

**Value**

If check passes then `assert` returns invisibly and `test/check` return `TRUE`. If check fails, `assert` stops code with error, `check` returns an error message as string, `test` returns `FALSE`.

**Examples**

```r
testNegativeSkew(Binomial$new())
```

---

description

Validation checks to test if Distribution is no skew.

**Usage**

```r
testNoSkew(object, errormsg = paste(object$short_name, "is not no skew"))
checkNoSkew(object, errormsg = paste(object$short_name, "is not no skew"))
assertNoSkew(object, errormsg = paste(object$short_name, "is not no skew"))
```

**Arguments**

<table>
<thead>
<tr>
<th>object</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>errormsg</td>
<td>custom error message to return if assert/check fails</td>
</tr>
</tbody>
</table>

**Value**

If check passes then `assert` returns invisibly and `test/check` return `TRUE`. If check fails, `assert` stops code with error, `check` returns an error message as string, `test` returns `FALSE`.

**Examples**

```r
testNoSkew(Binomial$new())
```
Description

Validation checks to test if a given object is a ParameterSet.

Usage

testParameterSet(
  object,
  errmsg = paste(object, "is not an R6 ParameterSet object")
)

checkParameterSet(
  object,
  errmsg = paste(object, "is not an R6 ParameterSet object")
)

assertParameterSet(
  object,
  errmsg = paste(object, "is not an R6 ParameterSet object")
)

Arguments

object object to test
errmsg custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

testParameterSet(5) # FALSE
testParameterSet(Binomial$new()$parameters()) # TRUE
testParameterSetCollection

Description
Validation checks to test if a given object is a ParameterSetCollection.

Usage

testParameterSetCollection(
   object,
   errmsg = paste(object, "is not an R6 ParameterSetCollection object")
)

checkParameterSetCollection(
   object,
   errmsg = paste(object, "is not an R6 ParameterSetCollection object")
)

assertParameterSetCollection(
   object,
   errmsg = paste(object, "is not an R6 ParameterSetCollection object")
)

Arguments

object       object to test
errmsg       custom error message to return if assert/check fails

Value
If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

# FALSE
testParameterSetCollection(5)
# TRUE
testParameterSetCollection(ParameterSetCollection$new(Binom = Binomial$new()$parameters()))
testParameterSetCollectionList

assert/check/test/ParameterSetCollectionList

Description

Validation checks to test if a given object is a list of ParameterSetCollections.

Usage

```r
testParameterSetCollectionList(
  object,
  errmsg = "One or more items in the list are not ParameterSetCollections"
)
```

```r
checkParameterSetCollectionList(
  object,
  errmsg = "One or more items in the list are not ParameterSetCollections"
)
```

```r
assertParameterSetCollectionList(
  object,
  errmsg = "One or more items in the list are not ParameterSetCollections"
)
```

Arguments

- **object**
  - object to test

- **errmsg**
  - custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

```r
testParameterSetCollectionList(list(Binomial$new(), 5)) # FALSE
testParameterSetCollectionList(list(ParameterSetCollection$new(
  Binom = Binomial$new()$parameters()
))) # TRUE
```
testParameterSetList  assert/check/test/ParameterSetList

Description

Validation checks to test if a given object is a list of ParameterSets.

Usage

testParameterSetList(
  object,
  errmsg = "One or more items in the list are not ParameterSets"
)

checkParameterSetList(
  object,
  errmsg = "One or more items in the list are not ParameterSets"
)

assertParameterSetList(
  object,
  errmsg = "One or more items in the list are not ParameterSets"
)

Arguments

object  object to test

errmsg  custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

testParameterSetList(list(Binomial$new(), 5)) # FALSE

testParameterSetList(list(Binomial$new(), Exponential$new())) # TRUE
Description

Validation checks to test if Distribution is platykurtic.

Usage

testPlatykurtic(
    object,
    errmsg = paste(object$short_name, "is not platykurtic")
)

checkPlatykurtic(
    object,
    errmsg = paste(object$short_name, "is not platykurtic")
)

assertPlatykurtic(
    object,
    errmsg = paste(object$short_name, "is not platykurtic")
)

Arguments

object    Distribution
errmsg    custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

testPlatykurtic(Binomial$new())
testPositiveSkew

Description

Validation checks to test if Distribution is positive skew.

Usage

testPositiveSkew(
  object,
  errmsg = paste(object$short_name, "is not positive skew")
)

checkPositiveSkew(
  object,
  errmsg = paste(object$short_name, "is not positive skew")
)

assertPositiveSkew(
  object,
  errmsg = paste(object$short_name, "is not positive skew")
)

Arguments

  object  Distribution
  errmsg  custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

testPositiveSkew(Binomial$new())
testSymmetric

Description

Validation checks to test if Distribution is symmetric.

Usage

testSymmetric(object, errmsg = paste(object$short_name, "is not symmetric"))

checkSymmetric(object, errmsg = paste(object$short_name, "is not symmetric"))

assertSymmetric(
  object,
  errmsg = paste(object$short_name, "is not symmetric")
)

Arguments

  object     Distribution
  errmsg     custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

testSymmetric(Binomial$new()) # FALSE

testUnivariate

Description

Validation checks to test if Distribution is univariate.
traits

Usage

testUnivariate(
    object,
    errmsg = paste(object$short_name, "is not univariate")
)

checkUnivariate(
    object,
    errmsg = paste(object$short_name, "is not univariate")
)

assertUnivariate(
    object,
    errmsg = paste(object$short_name, "is not univariate")
)

Arguments

object    Distribution
errmsg    custom error message to return if assert/check fails

Value

If check passes then assert returns invisibly and test/check return TRUE. If check fails, assert stops code with error, check returns an error message as string, test returns FALSE.

Examples

testUnivariate(Binomial$new()) # TRUE

---

traits    Traits Accessor

Description

Returns the traits of the distribution.

Usage

traits(object)

Arguments

object    Distribution.

Value

List of traits.
**Triangular Distribution Class**

**Description**

Mathematical and statistical functions for the Triangular distribution, which is commonly used to model population data where only the minimum, mode and maximum are known (or can be reliably estimated), also to model the sum of standard uniform distributions.

**Details**

The Triangular distribution parameterised with lower limit, $a$, upper limit, $b$, and mode, $c$, is defined by the pdf,

\[
\begin{align*}
    f(x) &= 0, \quad x < a \\
    f(x) &= 2(x - a)/((b - a)(c - a)), \quad a \leq x < c \\
    f(x) &= 2/(b - a), \quad x = c \\
    f(x) &= 2(b - x)/((b - a)(b - c)), \quad c < x \leq b \\
    f(x) &= 0, \quad x > b \quad \text{for} \quad a, b, c \in \mathbb{R}, \quad a \leq c \leq b.
\end{align*}
\]

**Value**

Returns an R6 object inheriting from class `SDistribution`.

**Distribution support**

The distribution is supported on $[a, b]$.

**Default Parameterisation**

Tri(lower = 0, upper = 1, mode = 0.5, symmetric = FALSE)

**Omitted Methods**

N/A

**Also known as**

N/A

**Super classes**

`distr6::Distribution` -> `distr6::SDistribution` -> Triangular
Public fields

- **name** Full name of distribution.
- **short_name** Short name of distribution for printing.
- **description** Brief description of the distribution.
- **packages** Packages required to be installed in order to construct the distribution.

Methods

Public methods:

- `Triangular$new()`
- `Triangular$mean()`
- `Triangular$mode()`
- `Triangular$median()`
- `Triangular$variance()`
- `Triangular$skewness()`
- `Triangular$kurtosis()`
- `Triangular$entropy()`
- `Triangular$mgf()`
- `Triangular$cf()`
- `Triangular$pgf()`
- `Triangular$setParameterValue()`
- `Triangular$clone()`

**Method** `new()`: Creates a new instance of this R6 class.

*Usage:*

```r
Triangular$new(
  lower = NULL,
  upper = NULL,
  mode = NULL,
  symmetric = NULL,
  decorators = NULL
)
```

*Arguments:*

- **lower** (`numeric(1)`)
  - Lower limit of the Distribution, defined on the Reals.
- **upper** (`numeric(1)`)
  - Upper limit of the Distribution, defined on the Reals.
- **mode** (`numeric(1)`)
  - Mode of the distribution, if `symmetric = TRUE` then determined automatically.
- **symmetric** (`logical(1)`)  
  - If `TRUE` then the symmetric Triangular distribution is constructed, where the mode is automatically calculated. Otherwise mode can be set manually. Cannot be changed after construction.
Decorators (character())

Decorators to add to the distribution during construction.

Examples:
Triangular$new(lower = 2, upper = 5, symmetric = TRUE)
Triangular$new(lower = 2, upper = 5, symmetric = FALSE)
Triangular$new(lower = 2, upper = 5, mode = 4)

# You can view the type of Triangular distribution with $description
Triangular$new(lower = 2, upper = 5, symmetric = TRUE)$description
Triangular$new(lower = 2, upper = 5, symmetric = FALSE)$description

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

\[ E_X(X) = \sum p_X(x) \cdot x \]

with an integration analogue for continuous distributions.

Usage:
Triangular$mean(...)

Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Triangular$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
    Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method median(): Returns the median of the distribution. If an analytical expression is available returns distribution median, otherwise if symmetric returns self$mean, otherwise returns self$quantile(0.5).

Usage:
Triangular$median()

Method variance(): The variance of a distribution is defined by the formula

\[ var_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
Triangular$variance(...)

Arguments:
... Unused.
Method skewness(): The skewness of a distribution is defined by the third standardised moment,

$$sk_X = E_X \left[ \frac{x - \mu}{\sigma}^3 \right]$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution.

Usage:
Triangular$skewness(...)

Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

$$k_X = E_X \left[ \frac{x - \mu}{\sigma}^4 \right]$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
Triangular$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))
    If TRUE (default) excess kurtosis returned.
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by

$$- \sum (f_X) \log(f_X)$$

where $f_X$ is the pdf of distribution $X$, with an integration analogue for continuous distributions.

Usage:
Triangular$entropy(base = 2, ...)

Arguments:
basis (integer(1))
    Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method mgf(): The moment generating function is defined by

$$mgf_X(t) = E_X[exp(xt)]$$

where $X$ is the distribution and $E_X$ is the expectation of the distribution $X$.

Usage:
Triangular$mgf(t, ...)

Arguments:
Method \texttt{cf}(): The characteristic function is defined by
$$cf_X(t) = E_X[exp(x ti)]$$
where \(X\) is the distribution and \(E_X\) is the expectation of the distribution \(X\).

Usage:
\texttt{Triangular$cf(t, \ldots)$}

Arguments:
\(t\) (integer(1))
\(t\) integer to evaluate function at.
... Unused.

Method \texttt{pgf}(): The probability generating function is defined by
$$pgf_X(z) = E_X[exp(x z)]$$
where \(X\) is the distribution and \(E_X\) is the expectation of the distribution \(X\).

Usage:
\texttt{Triangular$pgf(z, \ldots)$}

Arguments:
\(z\) (integer(1))
\(z\) integer to evaluate probability generating function at.
... Unused.

Method \texttt{setParameterValue}(): Sets the value(s) of the given parameter(s).

Usage:
\texttt{Triangular$setParameterValue( \ldots, \lst = NULL, error = "warn", resolveConflicts = FALSE)$}

Arguments:
\(\ldots\) ANY
Named arguments of parameters to set values for. See examples.
\lst (list(1))
Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.
\error (character(1))
If "warn" then returns a warning on error, otherwise breaks if "stop".
\resolveConflicts (logical(1))
If FALSE (default) throws error if conflicting parameterisations are provided, otherwise automatically resolves them by removing all conflicting parameters.
**Method** `clone()`: The objects of this class are cloneable with this method.

**Usage:**

`Triangular$clone(deep = FALSE)`

**Arguments:**

depth Whether to make a deep clone.

**References**

Michael P. McLaughlin.

**See Also**

Other continuous distributions: `Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Uniform, Wald, Weibull`  
Other univariate distributions: `Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Uniform, Wald, Weibull, WeightedDiscrete`

**Examples**

```r
## ------------------------------------------------
## Method \`Triangular\$new`  
## ------------------------------------------------

Triangular$new(lower = 2, upper = 5, symmetric = TRUE)  
Triangular$new(lower = 2, upper = 5, symmetric = FALSE)  
Triangular$new(lower = 2, upper = 5, mode = 4)  
# You can view the type of Triangular distribution with \$description  
Triangular$new(lower = 2, upper = 5, symmetric = TRUE)$description  
Triangular$new(lower = 2, upper = 5, symmetric = FALSE)$description
```

---

**TriangularKernel**

**Triangular Kernel**

**Description**

Mathematical and statistical functions for the Triangular kernel defined by the pdf,

\[ f(x) = 1 - |x| \]

over the support \( x \in (-1, 1) \).
Super classes

\[ \text{distr6::Distribution} \rightarrow \text{distr6::Kernel} \rightarrow \text{TriangularKernel} \]

Public fields

- **name**: Full name of distribution.
- **short_name**: Short name of distribution for printing.
- **description**: Brief description of the distribution.

Methods

Public methods:

- \text{TriangularKernel$pdfSquared2Norm()} 
- \text{TriangularKernel$cdfSquared2Norm()} 
- \text{TriangularKernel$variance()} 
- \text{TriangularKernel$clone()} 

**Method** $pdfSquared2Norm()$: The squared 2-norm of the pdf is defined by

\[
\int_a^b (f_X(u))^2\,du
\]

where \( X \) is the Distribution, \( f_X \) is its pdf and \( a, b \) are the distribution support limits.

**Usage**:

\text{TriangularKernel$pdfSquared2Norm(x = 0, upper = Inf)}

**Arguments**:

- \text{x (numeric(1))}
  
  Amount to shift the result.

- \text{upper (numeric(1))}
  
  Upper limit of the integral.

**Method** $cdfSquared2Norm()$: The squared 2-norm of the cdf is defined by

\[
\int_a^b (F_X(u))^2\,du
\]

where \( X \) is the Distribution, \( F_X \) is its pdf and \( a, b \) are the distribution support limits.

**Usage**:

\text{TriangularKernel$cdfSquared2Norm(x = 0, upper = 0)}

**Arguments**:

- \text{x (numeric(1))}
  
  Amount to shift the result.

- \text{upper (numeric(1))}
  
  Upper limit of the integral.
Method variance(): The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
TriangularKernel$variance(...)

Arguments:
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
TriangularKernel$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

See Also
Other kernels: Cosine, Epanechnikov, LogisticKernel, NormalKernel, Quartic, Sigmoid, Silverman, Tricube, Triweight, UniformKernel

---

Tricube  
Tricube Kernel

Description
Mathematical and statistical functions for the Tricube kernel defined by the pdf,

\[ f(x) = \frac{70}{81}(1 - |x|^3)^3 \]

over the support \( x \in (-1, 1) \).

Details
The quantile function is omitted as no closed form analytic expressions could be found, decorate with FunctionImputation for numeric results.

Super classes
distr6::Distribution -> distr6::Kernel -> Tricube

Public fields
name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
Methods

**Public methods:**
- `Tricube$pdfSquared2Norm()`
- `Tricube$cdfSquared2Norm()`
- `Tricube$variance()`
- `Tricube$clone()`

**Method pdfSquared2Norm():** The squared 2-norm of the pdf is defined by
\[
\int_{a}^{b} (f_X(u))^2 \, du
\]
where \(X\) is the Distribution, \(f_X\) is its pdf and \(a, b\) are the distribution support limits.

**Usage:**
`Tricube$pdfSquared2Norm(x = 0, upper = 0)`

**Arguments:**
- `x` (numeric(1))
  - Amount to shift the result.
- `upper` (numeric(1))
  - Upper limit of the integral.

**Method cdfSquared2Norm():** The squared 2-norm of the cdf is defined by
\[
\int_{a}^{b} (F_X(u))^2 \, du
\]
where \(X\) is the Distribution, \(F_X\) is its pdf and \(a, b\) are the distribution support limits.

**Usage:**
`Tricube$cdfSquared2Norm(x = 0, upper = 0)`

**Arguments:**
- `x` (numeric(1))
  - Amount to shift the result.
- `upper` (numeric(1))
  - Upper limit of the integral.

**Method variance():** The variance of a distribution is defined by the formula
\[
var_X = E[X^2] - E[X]^2
\]
where \(E_X\) is the expectation of distribution \(X\). If the distribution is multivariate the covariance matrix is returned.

**Usage:**
`Tricube$variance(...)`

**Arguments:**
- `...` Unused.
Method clone(): The objects of this class are cloneable with this method.

Usage:
Tricube$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

See Also
Other kernels: Cosine, Epanechnikov, LogisticKernel, NormalKernel, Quartic, Sigmoid, Silverman, TriangularKernel, Triweight, UniformKernel

Description
Mathematical and statistical functions for the Triweight kernel defined by the pdf,
\[ f(x) = \frac{35}{32}(1 - x^2)^3 \]
over the support \( x \in (-1, 1) \).

Details
The quantile function is omitted as no closed form analytic expression could be found, decorate with FunctionImputation for numeric results.

Super classes
distr6::Distribution -> distr6::Kernel -> Triweight

Public fields
name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.

Methods
Public methods:
- Triweight$pdfSquared2Norm()
- Triweight$cdfSquared2Norm()
- Triweight$variance()
- Triweight$clone()
**Method** `pdfSquared2Norm()`: The squared 2-norm of the pdf is defined by
\[
\int_a^b (f_X(u))^2 \, du
\]
where $X$ is the Distribution, $f_X$ is its pdf and $a, b$ are the distribution support limits.

*Usage:*
Triweight$pdfSquared2Norm(x = 0, upper = Inf)

*Arguments:*
- `x` (numeric(1))
  - Amount to shift the result.
- `upper` (numeric(1))
  - Upper limit of the integral.

**Method** `cdfSquared2Norm()`: The squared 2-norm of the cdf is defined by
\[
\int_a^b (F_X(u))^2 \, du
\]
where $X$ is the Distribution, $F_X$ is its pdf and $a, b$ are the distribution support limits.

*Usage:*
Triweight$cdfSquared2Norm(x = 0, upper = 0)

*Arguments:*
- `x` (numeric(1))
  - Amount to shift the result.
- `upper` (numeric(1))
  - Upper limit of the integral.

**Method** `variance()`: The variance of a distribution is defined by the formula
\[
\text{var}_X = E[X^2] - E[X]^2
\]
where $E_X$ is the expectation of distribution $X$. If the distribution is multivariate the covariance matrix is returned.

*Usage:*
Triweight$variance(...)

*Arguments:*
- `...` Unused.

**Method** `clone()`: The objects of this class are cloneable with this method.

*Usage:*
Triweight$clone(deep = FALSE)

*Arguments:*
- `deep` Whether to make a deep clone.

**See Also**
Other kernels: Cosine, Epanechnikov, LogisticKernel, NormalKernel, Quartic, Sigmoid, Silverman, TriangularKernel, Tricube, UniformKernel
**Truncate a Distribution**

**Description**
S3 functionality to truncate an R6 distribution.

**Usage**
```
truncate(x, lower = NULL, upper = NULL)
```

**Arguments**
- `x` Distribution.
- `lower` lower limit for truncation.
- `upper` upper limit for truncation.

**See Also**
- `TruncatedDistribution`

---

**TruncatedDistribution Distribution Truncation Wrapper**

**Description**
A wrapper for truncating any probability distribution at given limits.

**Details**
The pdf and cdf of the distribution are required for this wrapper, if unavailable decorate with `FunctionImputation` first.

Truncates a distribution at lower and upper limits on a left-open interval, using the formulae

\[ f_T(x) = \frac{f_X(x)}{F_X(upper) - F_X(lower)} \]

\[ F_T(x) = \frac{(F_X(x) - F_X(lower))}{(F_X(upper) - F_X(lower))} \]

where \( f_T/F_T \) is the pdf/cdf of the truncated distribution \( T = \text{Truncate}(X, \text{lower}, \text{upper}) \) and \( f_X, F_X \) is the pdf/cdf of the original distribution. \( T \) is supported on \((-\infty, \infty)\).

**Super classes**
- `distr6::Distribution` -> `distr6::DistributionWrapper` -> `TruncatedDistribution`
Methods

Public methods:

• `TruncatedDistribution$new()`
• `TruncatedDistribution$setParameterValue()`
• `TruncatedDistribution$clone()`

Method `new()`: Creates a new instance of this R6 class.

Usage:
`TruncatedDistribution$new(distribution, lower = NULL, upper = NULL)`

Arguments:
distribution ([Distribution])
  `Distribution` to wrap.
lower (numeric(1))
  Lower limit to huberize the distribution at. If NULL then the lower bound of the `Distribution`
  is used.
upper (numeric(1))
  Upper limit to huberize the distribution at. If NULL then the upper bound of the `Distribution`
  is used.

Examples:
`TruncatedDistribution$new(
  Binomial$new(prob = 0.5, size = 10),
  lower = 2, upper = 4
)`

# alternate constructor
truncate(Binomial$new(), lower = 2, upper = 4)

Method `setParameterValue()`: Sets the value(s) of the given parameter(s).

Usage:
`TruncatedDistribution$setParameterValue(`
  ..., 
  lst = NULL, 
  error = "warn", 
  resolveConflicts = FALSE
)`

Arguments:

... ANY
  Named arguments of parameters to set values for. See examples.
lst (list(1))
  Alternative argument for passing parameters. List names should be parameter names and
  list values are the new values to set.
error (character(1))
  If "warn" then returns a warning on error, otherwise breaks if "stop".

resolveConflicts (logical(1))
If FALSE (default) throws error if conflicting parameterisations are provided, otherwise
automatically resolves them by removing all conflicting parameters.

**Method** `clone()`: The objects of this class are cloneable with this method.

**Usage**:
```
TruncatedDistribution$clone(deep = FALSE)
```

**Arguments**:
```
deep  Whether to make a deep clone.
```

**See Also**

Other wrappers: `Convolution`, `DistributionWrapper`, `HuberizedDistribution`, `MixtureDistribution`,
`ProductDistribution`, `VectorDistribution`

**Examples**

```r
## ------------------------------------------------
## Method `TruncatedDistribution$new`
## ------------------------------------------------
TruncatedDistribution$new(
  Binomial$new(prob = 0.5, size = 10),
  lower = 2, upper = 4
)
# alternate constructor
truncate(Binomial$new(), lower = 2, upper = 4)
```

---

**type**

*Type Accessor - Deprecated*

**Description**

Deprecated. Use `$traits$type`

**Usage**

```
type(object)
```

**Arguments**

```
object    Distribution.
```

**Value**

An R6 object of class `set6::Set`. 
Description

Mathematical and statistical functions for the Uniform distribution, which is commonly used to model continuous events occurring with equal probability, as an uninformed prior in Bayesian modelling, and for inverse transform sampling.

Details

The Uniform distribution parameterised with lower, $a$, and upper, $b$, limits is defined by the pdf,

$$f(x) = \frac{1}{b - a}$$

for $-\infty < a < b < \infty$.

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on $[a, b]$.

Default Parameterisation

Unif(lower = 0, upper = 1)

Omitted Methods

N/A

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> Uniform
Public fields

name   Full name of distribution.
short_name   Short name of distribution for printing.
description   Brief description of the distribution.
packages   Packages required to be installed in order to construct the distribution.

Methods

Public methods:

• Uniform$new()
• Uniform$mean()
• Uniform$mode()
• Uniform$variance()
• Uniform$skewness()
• Uniform$kurtosis()
• Uniform$entropy()
• Uniform$mgf()
• Uniform$cf()
• Uniform$pgf()
• Uniform$setParameterValue()
• Uniform$clone()

Method new(): Creates a new instance of this R6 class.

Usage:
Uniform$new(lower = NULL, upper = NULL, decorators = NULL)

Arguments:
lower (numeric(1))
   Lower limit of the Distribution, defined on the Reals.
upper (numeric(1))
   Upper limit of the Distribution, defined on the Reals.
decorators (character())
   Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution \(X\) is the expectation
\[
E_X(X) = \sum p_X(x) \cdot x
\]
with an integration analogue for continuous distributions.

Usage:
Uniform$mean(...)

Arguments:
... Unused.
Method `mode()`: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:
Uniform$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method `variance()`: The variance of a distribution is defined by the formula

\[ \text{var}_X = E[X^2] - E[X]^2 \]

where \( E_X \) is the expectation of distribution \( X \). If the distribution is multivariate the covariance matrix is returned.

Usage:
Uniform$variance(...)

Arguments:
... Unused.

Method `skewness()`: The skewness of a distribution is defined by the third standardised moment,

\[ sk_X = E_X \left[ \frac{x - \mu}{\sigma}^3 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
Uniform$skewness(...)

Arguments:
... Unused.

Method `kurtosis()`: The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma}^4 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
Uniform$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))
  If TRUE (default) excess kurtosis returned.
... Unused.
**Method** entropy(): The entropy of a (discrete) distribution is defined by

\[- \sum (f_X) \log(f_X)\]

where \(f_X\) is the pdf of distribution \(X\), with an integration analogue for continuous distributions.

*Usage:*
Uniform$entropy(base = 2, ...)

*Arguments:*
base (integer(1))
- Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

**Method** mgf(): The moment generating function is defined by

\[mgf_X(t) = E_X[exp(xt)]\]

where \(X\) is the distribution and \(E_X\) is the expectation of the distribution \(X\).

*Usage:*
Uniform$mgf(t, ...)

*Arguments:*
t (integer(1))
- t integer to evaluate function at.
... Unused.

**Method** cf(): The characteristic function is defined by

\[cf_X(t) = E_X[exp(xti)]\]

where \(X\) is the distribution and \(E_X\) is the expectation of the distribution \(X\).

*Usage:*
Uniform$cf(t, ...)

*Arguments:*
t (integer(1))
- t integer to evaluate function at.
... Unused.

**Method** pgf(): The probability generating function is defined by

\[pgf_X(z) = E_X[exp(xz)]\]

where \(X\) is the distribution and \(E_X\) is the expectation of the distribution \(X\).

*Usage:*
Uniform$pgf(z, ...)

*Arguments:*
z (integer(1))
- z integer to evaluate probability generating function at.
Method `setParameterValue()`: Sets the value(s) of the given parameter(s).

Usage:
Uniform$setParameterValue(
  ..., 
  lst = NULL, 
  error = "warn", 
  resolveConflicts = FALSE
)

Arguments:
  ... ANY
  Named arguments of parameters to set values for. See examples.
  lst (list(1))
  Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.
  error (character(1))
  If "warn" then returns a warning on error, otherwise breaks if "stop".
  resolveConflicts (logical(1))
  If FALSE (default) throws error if conflicting parameterisations are provided, otherwise automatically resolves them by removing all conflicting parameters.

Method `clone()`: The objects of this class are cloneable with this method.

Usage:
Uniform$clone(deep = FALSE)

Arguments:
  deep Whether to make a deep clone.

Author(s)
Yumi Zhou

References

See Also
Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Wald, Weibull

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz,
Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Wald, Weibull, WeightedDiscrete

---

**UniformKernel**  
**Uniform Kernel**

**Description**

Mathematical and statistical functions for the Uniform kernel defined by the pdf,

\[ f(x) = \frac{1}{2} \]

over the support \( x \in (-1, 1) \).

**Super classes**

distr6::Distribution -> distr6::Kernel -> UniformKernel

**Public fields**

- name: Full name of distribution.
- short_name: Short name of distribution for printing.
- description: Brief description of the distribution.

**Methods**

**Public methods:**

- UniformKernel$pdfSquared2Norm()  
- UniformKernel$cdfSquared2Norm()  
- UniformKernel$variance()  
- UniformKernel$clone()

**Method pdfSquared2Norm():** The squared 2-norm of the pdf is defined by

\[ \int_a^b (f_X(u))^2 \, du \]

where \( X \) is the Distribution, \( f_X \) is its pdf and \( a, b \) are the distribution support limits.

**Usage:**

UniformKernel$pdfSquared2Norm(x = 0, upper = Inf)

**Arguments:**

- x (numeric(1))  
  Amount to shift the result.
- upper (numeric(1))  
  Upper limit of the integral.
Method cdfSquared2Norm(): The squared 2-norm of the cdf is defined by
\[ \int_a^b (F_X(u))^2 \, du \]
where X is the Distribution, \( F_X \) is its pdf and \( a, b \) are the distribution support limits.

Usage:
UniformKernel$cdfSquared2Norm(x = 0, upper = 0)

Arguments:
x (numeric(1))
  Amount to shift the result.
upper (numeric(1))
  Upper limit of the integral.

Method variance(): The variance of a distribution is defined by the formula
\[ \text{var}_X = E[X^2] - E[X]^2 \]
where \( E_X \) is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

Usage:
UniformKernel$variance(...) 

Arguments:
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
UniformKernel$clone(deep = FALSE)

Arguments:
deep Whether to make a deep clone.

See Also
Other kernels: Cosine, Epanechnikov, LogisticKernel, NormalKernel, Quartic, Sigmoid, Silverman, TriangularKernel, Tricube, Triweight

description

Value Support Accessor - Deprecated

Usage
valueSupport(object)
Arguments
    object    Distribution.

Value
    One of "discrete"/"continuous"/"mixture".

---

variance

Distribution Variance

Description
    The variance or covariance of a distribution, either calculated analytically if or estimated numerically.

Usage
    variance(object, ...)

Arguments
    object    Distribution.
    ...    Passed to $genExp.

Value
    Variance as a numeric.

---

variateForm

Variate Form Accessor - Deprecated

Description
    Deprecated. Use $traits$variateForm

Usage
    variateForm(object)

Arguments
    object    Distribution.

Value
    One of "univariate"/"multivariate"/"matrixvariate". 
Description

A wrapper for creating a vector of distributions.

Details

A vector distribution is intended to vectorize distributions more efficiently than storing a list of distributions. To improve speed and reduce memory usage, distributions are only constructed when methods (e.g. d/p/q/r) are called.

Super classes

distr6::Distribution -> distr6::DistributionWrapper -> VectorDistribution

Active bindings

modelTable  Returns reference table of wrapped Distributions.
distlist Returns list of constructed wrapped Distributions.
ids Returns ids of constructed wrapped Distributions.

Methods

Public methods:

- VectorDistribution$new()
- VectorDistribution$wrappedModels()
- VectorDistribution$strprint()
- VectorDistribution$mean()
- VectorDistribution$mode()
- VectorDistribution$median()
- VectorDistribution$variance()
- VectorDistribution$skewness()
- VectorDistribution$kurtosis()
- VectorDistribution$entropy()
- VectorDistribution$mgf()
- VectorDistribution$cf()
- VectorDistribution$pgf()
- VectorDistribution$pdf()
- VectorDistribution$cdf()
- VectorDistribution$cdf()
- VectorDistribution$quantile()
- VectorDistribution$rand()
- VectorDistribution$clone()
**Method** new(): Creates a new instance of this R6 class.

**Usage:**

```
VectorDistribution$new(
  distlist = NULL,
  distribution = NULL,
  params = NULL,
  shared_params = NULL,
  name = NULL,
  short_name = NULL,
  decorators = NULL,
  vecdist = NULL,
  ids = NULL,
  ...
)
```

**Arguments:**

- **distlist** (list())
  
  List of Distributions.

- **distribution** (character(1))
  
  Should be supplied with params and optionally shared_params as an alternative to distlist. Much faster implementation when only one class of distribution is being wrapped. distribution is the full name of one of the distributions in listDistributions(), or "Distribution" if constructing custom distributions. See examples in VectorDistribution.

- **params** (list()|data.frame())
  
  Parameters in the individual distributions for use with distribution. Can be supplied as a list, where each element is the list of parameters to set in the distribution, or as an object coercable to data.frame, where each column is a parameter and each row is a distribution. See examples in VectorDistribution.

- **shared_params** (list())
  
  If any parameters are shared when using the distribution constructor, this provides a much faster implementation to list and query them together. See examples in VectorDistribution.

- **name** (character(1))
  
  Optional name of wrapped distribution.

- **short_name** (character(1))
  
  Optional short name/ID of wrapped distribution.

- **decorators** (character())
  
  Decorators to add to the distribution during construction.

- **vecdist** VectorDistribution
  
  Alternative constructor to directly create this object from an object inheriting from VectorDistribution.

- **ids** (character())
  
  Optional ids for wrapped distributions in vector, should be unique and of same length as the number of distributions.

**Examples:**
VectorDistribution$new(
  distribution = "Binomial",
  params = list(
    list(prob = 0.1, size = 2),
    list(prob = 0.6, size = 4),
    list(prob = 0.2, size = 6)
  )
)

VectorDistribution$new(
  distribution = "Binomial",
  params = data.table::data.table(prob = c(0.1, 0.6, 0.2), size = c(2, 4, 6))
)

# Alternatively
VectorDistribution$new(
  list(
    Binomial$new(prob = 0.1, size = 2),
    Binomial$new(prob = 0.6, size = 4),
    Binomial$new(prob = 0.2, size = 6)
  )
)

Method wrappedModels(): Returns model(s) wrapped by this wrapper.

Usage:
VectorDistribution$wrappedModels(model = NULL)

Arguments:
model (character(1))
  id of wrapped Distributions to return. If NULL (default), a list of all wrapped Distributions is returned; if only one Distribution is matched then this is returned, otherwise a list of Distributions.

Method strprint(): Printable string representation of the VectorDistribution. Primarily used internally.

Usage:
VectorDistribution$strprint(n = 10)

Arguments:

  n (integer(1))
    Number of distributions to include when printing.

Method mean(): Returns named vector of means from each wrapped Distribution.

Usage:
VectorDistribution$mean(...)

Arguments:
Method mode(): Returns named vector of modes from each wrapped Distribution.

Usage:
VectorDistribution$mode(which = "all")

Arguments:
which (character(1) | numeric(1))
   Ignored if distribution is unimodal. Otherwise “all” returns all modes, otherwise specifies which mode to return.

Method median(): Returns named vector of medians from each wrapped Distribution.

Usage:
VectorDistribution$median()

Method variance(): Returns named vector of variances from each wrapped Distribution.

Usage:
VectorDistribution$variance(...)

Arguments:
... Passed to CoreStatistics$genExp if numeric.

Method skewness(): Returns named vector of skewness from each wrapped Distribution.

Usage:
VectorDistribution$skewness(...)

Arguments:
... Passed to CoreStatistics$genExp if numeric.

Method kurtosis(): Returns named vector of kurtosis from each wrapped Distribution.

Usage:
VectorDistribution$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))
   If TRUE (default) excess kurtosis returned.
... Passed to CoreStatistics$genExp if numeric.

Method entropy(): Returns named vector of entropy from each wrapped Distribution.

Usage:
VectorDistribution$entropy(base = 2, ...)

Arguments:
base (integer(1))
   Base of the entropy logarithm, default = 2 (Shannon entropy)
... Passed to CoreStatistics$genExp if numeric.

Method mgf(): Returns named vector of mgf from each wrapped Distribution.
Usage:
VectorDistribution$mgf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Passed to CoreStatistics$genExp if numeric.

Method cf(): Returns named vector of cf from each wrapped Distribution.

Usage:
VectorDistribution$cf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Passed to CoreStatistics$genExp if numeric.

Method pgf(): Returns named vector of pgf from each wrapped Distribution.

Usage:
VectorDistribution$pgf(z, ...)

Arguments:
z (integer(1))
  z integer to evaluate probability generating function at.
... Passed to CoreStatistics$genExp if numeric.

Method pdf(): Returns named vector of pdfs from each wrapped Distribution.

Usage:
VectorDistribution$pdf(..., log = FALSE, simplify = TRUE, data = NULL)

Arguments:
... (numeric())
  Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

log (logical(1))
  If TRUE returns the logarithm of the probabilities. Default is FALSE.
simplify logical(1)
  If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.
data array
  Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

Examples:
vd <- VectorDistribution$new(
  distribution = "Binomial",
  params = data.frame(size = 9:10, prob = c(0.5, 0.6)))

vd$pdf(2)
# Equivalently
vd$pdf(2, 2)

vd$pdf(1:2, 3:4)
# or as a matrix
vd$pdf(data = matrix(1:4, nrow = 2))

# when wrapping multivariate distributions, arrays are required
vd <- VectorDistribution$new(
  distribution = "Multinomial",
  params = list(
    list(size = 5, probs = c(0.1, 0.9)),
    list(size = 8, probs = c(0.3, 0.7))
  )
)

# evaluates Multinom1 and Multinom2 at (1, 4)
vd$pdf(1, 4)

# evaluates Multinom1 at (1, 4) and Multinom2 at (5, 3)
vd$pdf(data = array(c(1, 4, 5, 3), dim = c(1, 2, 2)))

# and the same across many samples
vd$pdf(data = array(c(1, 2, 4, 3, 5, 1, 3, 7), dim = c(2, 2, 2)))

Method cdf(): Returns named vector of cdfs from each wrapped Distribution. Same usage as $pdf.

Usage:
VectorDistribution$cdf(
  ..., 
  lower.tail = TRUE, 
  log.p = FALSE, 
  simplify = TRUE, 
  data = NULL
)

Arguments:
  ... (numeric())
    Points to evaluate the function at Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.

lower.tail (logical(1))
    If TRUE (default), probabilities are X <= x, otherwise, P(X > x).
log.p (logical(1))
   If TRUE returns the logarithm of the probabilities. Default is FALSE.
simplify logical(1)
   If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.
data array
   Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

Method quantile(): Returns named vector of quantiles from each wrapped Distribution. Same usage as $cdf.

Usage:
VectorDistribution$quantile(
   ..., 
   lower.tail = TRUE, 
   log.p = FALSE, 
   simplify = TRUE, 
   data = NULL 
)

Arguments:
... (numeric())
   Points to evaluate the function at. Arguments do not need to be named. The length of each argument corresponds to the number of points to evaluate, the number of arguments corresponds to the number of variables in the distribution. See examples.
lower.tail (logical(1))
   If TRUE (default), probabilities are $X \leq x$, otherwise, $P(X > x)$.
log.p (logical(1))
   If TRUE returns the logarithm of the probabilities. Default is FALSE.
simplify logical(1)
   If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.
data array
   Alternative method to specify points to evaluate. If univariate then rows correspond with number of points to evaluate and columns correspond with number of variables to evaluate. In the special case of VectorDistributions of multivariate distributions, then the third dimension corresponds to the distribution in the vector to evaluate.

Method rand(): Returns data.table::data.table of draws from each wrapped Distribution.

Usage:
VectorDistribution$rand(n, simplify = TRUE)

Arguments:
n (numeric(1))
   Number of points to simulate from the distribution. If length greater than 1, then n <- length(n), simplify logical(1)
   If TRUE (default) simplifies the return if possible to a numeric, otherwise returns a data.table::data.table.
Method clone(): The objects of this class are cloneable with this method.

Usage:
VectorDistribution$clone(deep = FALSE)

Arguments:
dee: Whether to make a deep clone.

See Also
Other wrappers: Convolution, DistributionWrapper, HuberizedDistribution, MixtureDistribution, ProductDistribution, TruncatedDistribution

Examples

```r
## Method 'VectorDistribution$new'
## -----------------------------------

## Not run:
VectorDistribution$new(
  distribution = "Binomial",
  params = list(
    list(prob = 0.1, size = 2),
    list(prob = 0.6, size = 4),
    list(prob = 0.2, size = 6)
  )
)

VectorDistribution$new(
  distribution = "Binomial",
  params = data.table::data.table(prob = c(0.1, 0.6, 0.2), size = c(2, 4, 6))
)

# Alternatively
VectorDistribution$new(
  list(
    Binomial$new(prob = 0.1, size = 2),
    Binomial$new(prob = 0.6, size = 4),
    Binomial$new(prob = 0.2, size = 6)
  )
)

## End(Not run)

## Method 'VectorDistribution$pdf'
## -----------------------------------

vd <- VectorDistribution$new(
  distribution = "Binomial",
  params = data.frame(size = 9:10, prob = c(0.5, 0.6)))
```
vd$pdf(2)
  # Equivalently
vd$pdf(2, 2)

vd$pdf(1:2, 3:4)
  # or as a matrix
vd$pdf(data = matrix(1:4, nrow = 2))

  # when wrapping multivariate distributions, arrays are required
vd <- VectorDistribution$new(
  distribution = "Multinomial",
  params = list(
    list(size = 5, probs = c(0.1, 0.9)),
    list(size = 8, probs = c(0.3, 0.7))
  )
)

  # evaluates Multinom1 and Multinom2 at (1, 4)
vd$pdf(1, 4)

  # evaluates Multinom1 at (1, 4) and Multinom2 at (5, 3)
vd$pdf(data = array(c(1,4,5,3), dim = c(1,2,2)))

  # and the same across many samples
vd$pdf(data = array(c(1,2,4,3,5,1,3,7), dim = c(2,2,2)))

Wald

Wald Distribution Class

Description

Mathematical and statistical functions for the Wald distribution, which is commonly used for modelling the first passage time for Brownian motion.

Details

The Wald distribution parameterised with mean, $\mu$, and shape, $\lambda$, is defined by the pdf,

$$f(x) = \left(\frac{\lambda}{2x^3\pi}\right)^{1/2}e^{\frac{-(\lambda(x - \mu)^2)}{2\mu^2x}}$$

for $\lambda > 0$ and $\mu > 0$.

Sampling is performed as per Michael, Schucany, Haas (1976).

Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on the Positive Reals.
**Default Parameterisation**

Wald(mean = 1, shape = 1)

**Omitted Methods**

quantile is omitted as no closed form analytic expression could be found, decorate with `FunctionImputation` for a numerical imputation.

**Also known as**

Also known as the Inverse Normal distribution.

**Super classes**

distr6::Distribution -> distr6::SDistribution -> Wald

**Public fields**

- name Full name of distribution.
- short_name Short name of distribution for printing.
- description Brief description of the distribution.
- packages Packages required to be installed in order to construct the distribution.

**Methods**

**Public methods:**

- `Wald$new()`  
- `Wald$mean()`  
- `Wald$mode()`  
- `Wald$variance()`  
- `Wald$skewness()`  
- `Wald$kurtosis()`  
- `Wald$mgf()`  
- `Wald$cf()`  
- `Wald$pgf()`  
- `Wald$clone()`

**Method new():** Creates a new instance of this R6 class.

**Usage:**

Wald$new(mean = NULL, shape = NULL, decorators = NULL)

**Arguments:**

- mean (numeric(1))  
  Mean of the distribution, location parameter, defined on the positive Reals.
- shape (numeric(1))  
  Shape parameter, defined on the positive Reals.
decorators (character())

Decorators to add to the distribution during construction.

**Method mean()**: The arithmetic mean of a (discrete) probability distribution $X$ is the expectation

$$E_X(X) = \sum p_X(x) \times x$$

with an integration analogue for continuous distributions.

*Usage:*

\[
\text{Wald$\$mean(...)}
\]

*Arguments:*

... Unused.

**Method mode()**: The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

*Usage:*

\[
\text{Wald$\$mode(which = "all")}
\]

*Arguments:*

which (character(1) | numeric(1))

Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

**Method variance()**: The variance of a distribution is defined by the formula

$$\text{var}_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution $X$. If the distribution is multivariate the covariance matrix is returned.

*Usage:*

\[
\text{Wald$\$variance(...)}
\]

*Arguments:*

... Unused.

**Method skewness()**: The skewness of a distribution is defined by the third standardised moment,

$$sk_X = E_X\left[\frac{x - \mu}{\sigma}\right]^3$$

where $E_X$ is the expectation of distribution $X$, $\mu$ is the mean of the distribution and $\sigma$ is the standard deviation of the distribution.

*Usage:*

\[
\text{Wald$\$skewness(...)}
\]

*Arguments:*

... Unused.
Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
Wald$kurtosis(excess = TRUE, ...)

Arguments:
excess (logical(1))
  If TRUE (default) excess kurtosis returned.
... Unused.

Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X[exp(xt)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Wald$mgf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Unused.

Method cf(): The characteristic function is defined by

\[ cf_X(t) = E_X[exp(xti)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Wald$cf(t, ...)

Arguments:
t (integer(1))
  t integer to evaluate function at.
... Unused.

Method pgf(): The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(zx)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
Wald$pgf(z, ...)

Arguments:
z (integer(1))
  z integer to evaluate probability generating function at.
... Unused.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Wald$clone(deep = FALSE)

Arguments:
depth Whether to make a deep clone.

References
Michael P. McLaughlin.


See Also
Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Weibull
Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Weibull, WeightedDiscrete

Weibull Distribution Class

Description
Mathematical and statistical functions for the Weibull distribution, which is commonly used in survival analysis as it satisfies both PH and AFT requirements.

Details
The Weibull distribution parameterised with shape, $\alpha$, and scale, $\beta$, is defined by the pdf,

$$ f(x) = \left(\frac{\alpha}{\beta}\right)(x/\beta)^{\alpha-1}\exp(-x/\beta)^{\alpha} $$

for $\alpha, \beta > 0$. 

Value
Returns an R6 object inheriting from class SDistribution.

Distribution support
The distribution is supported on the Positive Reals.

Default Parameterisation
Weibull(shape = 1, scale = 1)

Omitted Methods
N/A

Also known as
N/A

Super classes
distr6::Distribution -> distr6::SDistribution -> Weibull

Public fields
name Full name of distribution.
short_name Short name of distribution for printing.
description Brief description of the distribution.
packages Packages required to be installed in order to construct the distribution.

Methods
Public methods:
• Weibull$new()
• Weibull$mean()
• Weibull$mode()
• Weibull$median()
• Weibull$variance()
• Weibull$skewness()
• Weibull$kurtosis()
• Weibull$entropy()
• Weibull$pgf()
• Weibull$clone()

Method new(): Creates a new instance of this R6 class.
Usage:
Weibull$new(shape = NULL, scale = NULL, altscale = NULL, decorators = NULL)
Arguments:

shape (numeric(1))
  Shape parameter, defined on the positive Reals.
scale (numeric(1))
  Scale parameter, defined on the positive Reals.
altscale (numeric(1))
  Alternative scale parameter, if given then scale is ignored. altscale = scale^{-shape}.
decorators (character())
  Decorators to add to the distribution during construction.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

$$E_X(X) = \sum p_X(x) \times x$$

with an integration analogue for continuous distributions.

Usage:

Weibull$mean(...) 

Arguments:

... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).

Usage:

Weibull$mode(which = "all")

Arguments:

which (character(1) | numeric(1))
  Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies which mode to return.

Method median(): Returns the median of the distribution. If an analytical expression is available returns distribution median, otherwise if symmetric returns self$mean, otherwise returns self$quantile(0.5).

Usage:

Weibull$median()

Method variance(): The variance of a distribution is defined by the formula

$$var_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution X. If the distribution is multivariate the covariance matrix is returned.

Usage:

Weibull$variance(...) 

Arguments:

... Unused.
**Method skewness():** The skewness of a distribution is defined by the third standardised moment,

\[ sk_X = E_X \left[ \frac{x - \mu}{\sigma}^3 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

**Usage:**

```r
Weibull$skewness(...)
```

**Arguments:**

... Unused.

**Method kurtosis():** The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma}^4 \right] \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

**Usage:**

```r
Weibull$kurtosis(excess = TRUE, ...)
```

**Arguments:**

excess (logical(1))

If TRUE (default) excess kurtosis returned.

... Unused.

**Method entropy():** The entropy of a (discrete) distribution is defined by

\[-\sum (f_X) log(f_X)\]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

**Usage:**

```r
Weibull$entropy(base = 2, ...)
```

**Arguments:**

base (integer(1))

Base of the entropy logarithm, default = 2 (Shannon entropy)

... Unused.

**Method pgf():** The probability generating function is defined by

\[ pgf_X(z) = E_X[exp(z^x)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

**Usage:**

```r
Weibull$pgf(z, ...)
```

**Arguments:**
WeightedDiscrete

Description

Mathematical and statistical functions for the WeightedDiscrete distribution, which is commonly used in empirical estimators such as Kaplan-Meier.

Details

The WeightedDiscrete distribution is defined by the pmf,

\[ f(x_i) = p_i \]

for \( p_i, i = 1, \ldots, k; \sum p_i = 1. \)

Sampling from this distribution is performed with the sample function with the elements given as the x values and the pdf as the probabilities. The cdf and quantile assume that the elements are supplied in an indexed order (otherwise the results are meaningless).

The number of points in the distribution cannot be changed after construction.

Method clone(): The objects of this class are cloneable with this method.

Usage:

Weibull$clone(deep = FALSE)

Arguments:

depth Whether to make a deep clone.

References


See Also

Other continuous distributions: Arcsine, BetaNoncentral, Beta, Cauchy, ChiSquaredNoncentral, ChiSquared, Dirichlet, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Gompertz, Gumbel, InverseGamma, Laplace, Logistic, Loglogistic, Lognormal, MultivariateNormal, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical, Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang, Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz, Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal, NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral, StudentT, Triangular, Uniform, Wald, WeightedDiscrete

---

WeightedDiscrete

WeightedDiscrete Distribution Class

---

z (integer(1))

z integer to evaluate probability generating function at.

... Unused.

References

Michael P. McLaughlin.
Value

Returns an R6 object inheriting from class SDistribution.

Distribution support

The distribution is supported on $x_1, ..., x_k$.

Default Parameterisation

WeightDisc(x = 1, pdf = 1)

Omitted Methods

N/A

Also known as

N/A

Super classes

distr6::Distribution -> distr6::SDistribution -> WeightedDiscrete

Public fields

name  Full name of distribution.
short_name  Short name of distribution for printing.
description  Brief description of the distribution.

Methods

Public methods:

- WeightedDiscrete$new()
- WeightedDiscrete$strprint()
- WeightedDiscrete$mean()
- WeightedDiscrete$mode()
- WeightedDiscrete$variance()
- WeightedDiscrete$skewness()
- WeightedDiscrete$kurtosis()
- WeightedDiscrete$entropy()
- WeightedDiscrete$mgf()
- WeightedDiscrete$cf()
- WeightedDiscrete$pgf()
- WeightedDiscrete$setParameterValue()
- WeightedDiscrete$clone()

Method new(): Creates a new instance of this R6 class.
Usage:
WeightedDiscrete$new(x = NULL, pdf = NULL, cdf = NULL, decorators = NULL)

Arguments:
x numeric()
  Data samples, must be ordered in ascending order.
pdf numeric()
  Probability mass function for corresponding samples, should be same length x. If cdf is not
given then calculated as cumsum(pdf).
cdf numeric()
  Cumulative distribution function for corresponding samples, should be same length x. If
given then pdf is ignored and calculated as difference of cdfs.
decorators (character())
  Decorators to add to the distribution during construction.

Method strprint(): Printable string representation of the Distribution. Primarily used
internally.
Usage:
WeightedDiscrete$strprint(n = 2)
Arguments:
n (integer(1))
  Ignored.

Method mean(): The arithmetic mean of a (discrete) probability distribution X is the expectation

$$E_X(X) = \sum p_X(x) \cdot x$$

with an integration analogue for continuous distributions.
Usage:
WeightedDiscrete$mean(...)
Arguments:
... Unused.

Method mode(): The mode of a probability distribution is the point at which the pdf is a local
maximum, a distribution can be unimodal (one maximum) or multimodal (several maxima).
Usage:
WeightedDiscrete$mode(which = "all")
Arguments:
which (character(1) | numeric(1))
  Ignored if distribution is unimodal. Otherwise "all" returns all modes, otherwise specifies
  which mode to return.

Method variance(): The variance of a distribution is defined by the formula

$$var_X = E[X^2] - E[X]^2$$

where $E_X$ is the expectation of distribution X. If the distribution is multivariate the covariance
matrix is returned.
Usage:
WeightedDiscrete$variance(...)
Arguments:
... Unused.

Method skewness(): The skewness of a distribution is defined by the third standardised moment,

\[ sk_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^3 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution.

Usage:
WeightedDiscrete$skewness(...)
Arguments:
... Unused.

Method kurtosis(): The kurtosis of a distribution is defined by the fourth standardised moment,

\[ k_X = E_X \left[ \frac{x - \mu}{\sigma} \right]^4 \]

where \( E_X \) is the expectation of distribution \( X \), \( \mu \) is the mean of the distribution and \( \sigma \) is the standard deviation of the distribution. Excess Kurtosis is Kurtosis - 3.

Usage:
WeightedDiscrete$kurtosis(excess = TRUE, ...)
Arguments:
excess (logical(1))
  If TRUE (default) excess kurtosis returned.
... Unused.

Method entropy(): The entropy of a (discrete) distribution is defined by

\[- \sum (f_X) \log(f_X)\]

where \( f_X \) is the pdf of distribution \( X \), with an integration analogue for continuous distributions.

Usage:
WeightedDiscrete$entropy(base = 2, ...)
Arguments:
base (integer(1))
  Base of the entropy logarithm, default = 2 (Shannon entropy)
... Unused.

Method mgf(): The moment generating function is defined by

\[ mgf_X(t) = E_X[exp(xt)] \]

where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).
Usage:
WeightedDiscrete$mgf(t, ...)

Arguments:
t (integer(1))
    t integer to evaluate function at.
... Unused.

Method cf(): The characteristic function is defined by
\[ cf_X(t) = E_X[exp(\alpha t)] \]
where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
WeightedDiscrete$cf(t, ...)

Arguments:
t (integer(1))
    t integer to evaluate function at.
... Unused.

Method pgf(): The probability generating function is defined by
\[ pgf_X(z) = E_X[exp(z\alpha x)] \]
where \( X \) is the distribution and \( E_X \) is the expectation of the distribution \( X \).

Usage:
WeightedDiscrete$pgf(z, ...)

Arguments:
z (integer(1))
    z integer to evaluate probability generating function at.
... Unused.

Method setParameterValue(): Sets the value(s) of the given parameter(s).

Usage:
WeightedDiscrete$setParameterValue(
    ...,
    lst = NULL,
    error = "warn",
    resolveConflicts = FALSE
)

Arguments:
... ANY
    Named arguments of parameters to set values for. See examples.
lst (list(1))
    Alternative argument for passing parameters. List names should be parameter names and list values are the new values to set.
error (character(1))
  If "warn" then returns a warning on error, otherwise breaks if "stop".

resolveConflicts (logical(1))
  If FALSE (default) throws error if conflicting parameterisations are provided, otherwise auto-
matically resolves them by removing all conflicting parameters.

Method clone(): The objects of this class are cloneable with this method.

Usage:
WeightedDiscrete$clone(deep = FALSE)

Arguments:
deep  Whether to make a deep clone.

References
Michael P. McLaughlin.

See Also
Other discrete distributions: Bernoulli, Binomial, Categorical, Degenerate, DiscreteUniform,
EmpiricalMV, Empirical, Geometric, Hypergeometric, Logarithmic, Multinomial, NegativeBinomial

Other univariate distributions: Arcsine, Bernoulli, BetaNoncentral, Beta, Binomial, Categorical,
Cauchy, ChiSquaredNoncentral, ChiSquared, Degenerate, DiscreteUniform, Empirical, Erlang,
Exponential, FDistributionNoncentral, FDistribution, Frechet, Gamma, Geometric, Gompertz,
Gumbel, Hypergeometric, InverseGamma, Laplace, Logarithmic, Logistic, Loglogistic, Lognormal,
NegativeBinomial, Normal, Pareto, Poisson, Rayleigh, ShiftedLoglogistic, StudentTNoncentral,
StudentT, Triangular, Uniform, Wald, Weibull

Examples
x <- WeightedDiscrete$new(x = 1:3, pdf = c(1 / 5, 3 / 5, 1 / 5))
WeightedDiscrete$new(x = 1:3, cdf = c(1 / 5, 4 / 5, 1)) # equivalently

# d/p/q/r
x$pdf(1:5)
x$cdf(1:5) # Assumes ordered in construction
x$quantile(0.42) # Assumes ordered in construction
x$rand(10)

# Statistics
x$mean()
x$variance()

summary(x)
workingSupport

Description

If the distribution has an infinite support then this function calculates the approximate finite limits by finding the largest small number for which cdf == 0 and the smallest large number for which cdf == 1.

Usage

workingSupport(object)

Arguments

object   Distribution.

Value

set6 object.

wrappedModels

Description

Returns either a list of all the wrapped models or the models named by parameters.

Usage

wrappedModels(object, model = NULL)

Arguments

object   Distribution.
model    character, see details.

Value

If model is NULL then returns list of models that are wrapped by the wrapper. Otherwise returns model given in model.
[.ParameterSet  
*Extract one or more parameters from a ParameterSet*

**Description**

Used to extract one or more parameters from a constructed ParameterSet or ParameterSetCollection.

**Usage**

```r
## S3 method for class 'ParameterSet'
ps[ids, prefix = NULL, ...]
```

**Arguments**

- `ps`
  - *ParameterSet*
  - ParameterSet from which to extract parameters.

- `ids`
  - (character())
  - ids of parameters to extract, if id ends with __ then all parameters starting with ids__ are extracted and the prefix is ignored, prefix can be left NULL. See examples.

- `prefix`
  - (character(1))
  - An optional prefix to remove from ids after extraction, assumes __ follows the prefix name, i.e. prefix__ids.

- `...`
  - ANY
  - Ignored, added for consistency.

**Examples**

```r
ps <- VectorDistribution$new(
  distribution = "Binomial",
  params = data.table::data.table(prob = c(0.1, 0.6, 0.2), size = c(2, 4, 6))
)$parameters()

ps["Binom1__prob"] # extracts just Binom1__prob
ps["Binom1__prob", prefix = "Binom1"] # extracts Binom1__prob and removes prefix
ps["Binom1__"] # extracts all Binom1 parameters and removes prefix
```

[.VectorDistribution  
*Extract one or more Distributions from a VectorDistribution*

**Description**

Once a VectorDistribution has been constructed, use [ to extract one or more Distributions from inside it.
Usage

```r
## S3 method for class 'VectorDistribution'
vecdist[i]
```

Arguments

- `vecdist`: VectorDistribution from which to extract Distributions.
- `i`: indices specifying distributions to extract or ids of wrapped distributions.

Examples

```r
v <- VectorDistribution$new(distribution = "Binom", params = data.frame(size = 1:2))
v[1]
v["Binom1"]
```
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