

Package ‘param2moment’

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Type Package

Title Raw, Central and Standardized Moments of Parametric Distributions

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Description To calculate the raw, central and standardized moments from distribution parameters. To solve the distribution parameters based on user-provided mean, standard deviation, skewness and kurtosis. Normal, skew-normal, skew-t and Tukey g-&-h distributions are supported, for now.

License GPL-2

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Depends R (>= 4.4.0)

Imports methods

Suggests sn

RoxygenNote 7.3.2

NeedsCompilation no

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moment-class	<i>Raw, Central and Standardized Moments, and other Distribution Characteristics</i>
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Description

Up to 4th raw $E(Y^n)$, **central** $E[(Y - \mu)^n]$ and **standardized moments** $E[(Y - \mu)^n / \sigma^n]$ of the random variable

$$Y = (X - \text{location}) / \text{scale}$$

Also, the mean, standard deviation, skewness and excess kurtosis of the random variable X .

Details

For $Y = (X - \text{location}) / \text{scale}$, let $\mu = E(Y)$, then, according to **Binomial theorem**, the 2nd to 4th central moments of Y are,

$$E[(Y - \mu)^2] = E(Y^2) - 2\mu E(Y) + \mu^2 = E(Y^2) - \mu^2$$

$$E[(Y - \mu)^3] = E(Y^3) - 3\mu E(Y^2) + 3\mu^2 E(Y) - \mu^3 = E(Y^3) - 3\mu E(Y^2) + 2\mu^3$$

$$E[(Y - \mu)^4] = E(Y^4) - 4\mu E(Y^3) + 6\mu^2 E(Y^2) - 4\mu^3 E(Y) + \mu^4 = E(Y^4) - 4\mu E(Y^3) + 6\mu^2 E(Y^2) - 3\mu^4$$

The distribution characteristics of Y are,

$$\mu_Y = \mu$$

$$\sigma_Y = \sqrt{E[(Y - \mu)^2]}$$

$$\text{skewness}_Y = E[(Y - \mu)^3] / \sigma_Y^3$$

$$\text{kurtosis}_Y = E[(Y - \mu)^4] / \sigma_Y^4 - 3$$

The distribution characteristics of X are $\mu_X = \text{location} + \text{scale} \cdot \mu_Y$, $\sigma_X = \text{scale} \cdot \sigma_Y$, $\text{skewness}_X = \text{skewness}_Y$, and $\text{kurtosis}_X = \text{kurtosis}_Y$.

Slots

distname **character** scalar, name of distribution, e.g., 'norm' for normal, 'sn' for skew-normal, 'st' for skew-*t*, and 'GH' for Tukey *g*-&-*h* distribution, following the nomenclature of **dnorm**, **dsn**, **dst** and **QuantileGH::dGH**

location, scale **numeric** scalars or **vectors**, location and scale parameters

mu **numeric** scalar or **vector**, 1st *raw* moment $\mu = E(Y)$. Note that the 1st central moment $E(Y - \mu)$ and standardized moment $E(Y - \mu)/\sigma$ are both 0.

raw2, raw3, raw4 **numeric** scalars or **vectors**, 2nd or higher *raw* moments $E(Y^n)$, $n \geq 2$

central2, central3, central4 **numeric** scalars or **vectors**, 2nd or higher **central moments**, $\sigma^2 = E[(Y - \mu)^2]$ and $E[(Y - \mu)^n]$, $n \geq 3$

standardized3, standardized4 **numeric** scalars or **vectors**, 3rd or higher **standardized moments**, **skewness** $E[(Y - \mu)^3]/\sigma^3$ and **kurtosis** $E[(Y - \mu)^4]/\sigma^4$. Note that the 2nd standardized moment is 1

Note

Potential name clash with function `e1071::moment`.

moment2GH

*Solve Tukey *g*-&-*h* Parameters from Moments*

Description

Solve Tukey *g*-, *h*- and *g*-&-*h* distribution parameters from mean, standard deviation, skewness and kurtosis.

Usage

```
moment2GH(mean = 0, sd = 1, skewness, kurtosis)
```

```
moment2GH_h_demo(sd = 1, kurtosis)
```

```
moment2GH_g_demo(mean = 0, sd = 1, skewness)
```

Arguments

mean **numeric** scalar, mean μ , default value 0

sd **numeric** scalar, standard deviation σ , default value 1

skewness **numeric** scalar

kurtosis **numeric** scalar

Details

Function `moment2GH()` solves the location A , scale B , skewness g and elongation h parameters of Tukey g -&- h distribution, from user-specified mean μ (default 0), standard deviation σ (default 1), skewness and kurtosis.

An educational and demonstration function `moment2GH_h_demo()` solves (B, h) parameters of Tukey h -distribution, from user-specified σ and kurtosis. This is a non-skewed distribution, thus the location parameter $A = \mu = 0$, and the skewness parameter $g = 0$.

An educational and demonstration function `moment2GH_g_demo()` solves (A, B, g) parameters of Tukey g -distribution, from user-specified μ , σ and skewness. For this distribution, the elongation parameter $h = 0$.

Value

Function `moment2GH()` returns a **length-4 numeric vector** (A, B, g, h) .

Function `moment2GH_h_demo()` returns a **length-2 numeric vector** (B, h) .

Function `moment2GH_g_demo()` returns a **length-3 numeric vector** (A, B, g) .

Examples

```
moment2GH(skewness = .2, kurtosis = .3)
```

```
moment2GH_h_demo(kurtosis = .3)
```

```
moment2GH_g_demo(skewness = .2)
```

moment2param

Moment to Parameters: A Batch Process

Description

Converts multiple sets of moments to multiple sets of distribution parameters.

Usage

```
moment2param(distname, FUN = paste0("moment2", distname), ...)
```

Arguments

distname **character** scalar, distribution name. Currently supported are 'GH' for Tukey g -&- h distribution, 'sn' for skew-normal distribution and 'st' for skew- t distribution

FUN **name** or **character** scalar, (name of) **function** used to solve the distribution parameters from moments. Default is `paste0('moment2', distname)`, e.g., `moment2GH` will be used for `distname = 'GH'`. To use one of the educational functions, specify `FUN = moment2GH_g_demo` or `FUN = 'moment2GH_g_demo'`.

... **numeric** scalars, some or all of mean, sd, skewness and kurtosis (length will be recycled).

Value

Function `moment2param()` returns a [list](#) of [numeric vectors](#).

Examples

```
skw = c(.2, .5, .8)
krt = c(.5, 1, 1.5)
moment2param(distname = 'GH', skewness = skw, kurtosis = krt)
moment2param(distname = 'st', skewness = skw, kurtosis = krt)
```

moment2sn

Solve Skew-Normal Parameters from Moments

Description

Solve skew-normal parameters from mean, standard deviation and skewness.

Usage

```
moment2sn(mean = 0, sd = 1, skewness)
```

Arguments

mean	numeric scalar, mean μ , default value 0
sd	numeric scalar, standard deviation σ , default value 1
skewness	numeric scalar

Details

Function `moment2sn()` solves the location ξ , scale ω and slant α parameters of skew-normal distribution, from user-specified mean μ (default 0), standard deviation σ (default 1) and skewness.

Value

Function `moment2sn()` returns a [length-3 numeric vector](#) (ξ, ω, α) .

Examples

```
moment2sn(skewness = .3)
```

moment2st

*Solve Skew- t Parameters from Moments***Description**

Solve skew- t parameters from mean, standard deviation, skewness and kurtosis.

Usage

```
moment2st(mean = 0, sd = 1, skewness, kurtosis)
```

```
moment2t_demo(sd = 1, kurtosis)
```

Arguments

mean	numeric scalar, mean μ , default value 0
sd	numeric scalar, standard deviation σ , default value 1
skewness	numeric scalar
kurtosis	numeric scalar

Details

Function [moment2st\(\)](#) solves the location ξ , scale ω , slant α and degree of freedom ν parameters of skew- t distribution, from user-specified mean μ (default 0), standard deviation σ (default 1), skewness and kurtosis.

An educational and demonstration function [moment2t_demo](#) solves (ω, ν) parameters of t -distribution, from user-specified σ and kurtosis. This is a non-skewed distribution, thus the location parameter $\xi = \mu = 0$, and the slant parameter $\alpha = 0$.

Value

Function [moment2st\(\)](#) returns a [length-4 numeric vector](#) $(\xi, \omega, \alpha, \nu)$.

Function [moment2t_demo\(\)](#) returns a [length-2 numeric vector](#) (ω, ν) .

Examples

```
moment2st(skewness = .2, kurtosis = .3)
```

```
moment2t_demo(kurtosis = .3)
```

moment_GH

*Moments of Tukey g-&-h Distribution***Description**

Moments of Tukey g -&- h distribution.

Usage

```
moment_GH(A = 0, B = 1, g = 0, h = 0)
```

Arguments

A [numeric](#) scalar or [vector](#), location parameter A
 B [numeric](#) scalar or [vector](#), scale parameter B
 g [numeric](#) scalar or [vector](#), skewness parameter g
 h [numeric](#) scalar or [vector](#), elongation parameter h

Value

Function [moment_GH\(\)](#) returns a [moment](#) object.

References

Raw moments of Tukey g -&- h distribution: [doi:10.1002/9781118150702.ch11](https://doi.org/10.1002/9781118150702.ch11)

Examples

```
A = 3; B = 1.5; g = .7; h = .01
moment_GH(A = A, B = B, g = 0, h = h)
moment_GH(A = A, B = B, g = g, h = 0)
moment_GH(A = A, B = B, g = g, h = h)
```

moment_norm

*Moments of Normal Distribution***Description**

Moments of [normal distribution](#), parameter nomenclature follows [dnorm](#) function.

Usage

```
moment_norm(mean = 0, sd = 1)
```

Arguments

mean [numeric](#) scalar or [vector](#), mean parameter μ
 sd [numeric](#) scalar or [vector](#), standard deviation σ

Value

Function [moment_norm\(\)](#) returns a [moment](#) object.

Examples

```
moment_norm(mean = 1.2, sd = .7)
```

moment_sn	<i>Moments of Skew-Normal Distribution</i>
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Description

Moments of [skew-normal distribution](#), parameter nomenclature follows [dsn](#) function.

Usage

```
moment_sn(xi = 0, omega = 1, alpha = 0)
```

Arguments

xi [numeric](#) scalar or [vector](#), location parameter ξ
 omega [numeric](#) scalar or [vector](#), scale parameter ω
 alpha [numeric](#) scalar or [vector](#), slant parameter α

Value

Function [moment_sn\(\)](#) returns a [moment](#) object.

Examples

```
xi = 2; omega = 1.3; alpha = 3
moment_sn(xi, omega, alpha)
curve(sn::dsn(x, xi = 2, omega = 1.3, alpha = 3), from = 0, to = 6)
```

moment_st	<i>Moments of Skew-t Distribution</i>
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Description

Moments of skew- t distribution, parameter nomenclature follows [dst](#) function.

Usage

```
moment_st(xi = 0, omega = 1, alpha = 0, nu = Inf)
```

Arguments

xi	numeric scalar or vector , location parameter ξ
omega	numeric scalar or vector , scale parameter ω
alpha	numeric scalar or vector , slant parameter α
nu	numeric scalar or vector , degree of freedom ν

Value

Function [moment_st\(\)](#) returns a [moment](#) object.

References

Raw moments of skew- t : <https://arxiv.org/abs/0911.2342>

Examples

```
xi = 2; omega = 1.3; alpha = 3; nu = 6
curve(sn::dst(x, xi = xi, omega = omega, alpha = alpha, nu = nu), from = 0, to = 6)
moment_st(xi, omega, alpha, nu)
```

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