Package ‘neutrostat’

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Type Package

Title Neutrosophic Statistics

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Description Analyzes data involving imprecise and vague information. Provides summary statistics and describes the characteristics of neutrosophic data, as defined by Florentin Smarandache (2013).<ISBN:9781599732749>.

License GPL (>= 2)

Encoding UTF-8

LazyData true

URL https://github.com/kzst/neutrostat

Depends R (>= 4.00)

Imports moments, ntsDists, ggplot2, stats,

RoxygenNote 7.3.2

NeedsCompilation no

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Repository CRAN

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Contents

`citytemp` *Temperature Data of Five Different Cites in Pakistan for July 2022*

Description

This dataset provides low and high recordings of daily temperature for five different citites (Gujranwala,Lahore,Islambad, Karachi and Sialkot) of Pakistan for the specifed priod July 2022

Usage

```
data("citytemp")
```

Format

A data frame with 28 observations on the following 12 variables.

`Day` a character vector

`Date` a numeric vector

`Gujranwala_Low` a numeric vector

`Gujranwala_High` a numeric vector

`Lahore_Low` a numeric vector

`Lahore_High` a numeric vector

`Karachi_Low` a numeric vector

`Karachi_High` a numeric vector

`Islamabad_Low` a numeric vector

`Islamabad_High` a numeric vector

`Sialkot_Low` a numeric vector

`Sialkot_High` a numeric vector

Details

The data was collected for each city over 31 days in July 2022. It includes both the lower and upper temperature values, and can be analyzed using neutrosophic statistical approach.

Source

https://www.gismeteo.com/

References

Ishmal Shahzadi (2023): Neutrosophic Statistical Analysis of Temperature of Different Cities of Pakistan. Neutrosophic Sets and Systems, 53(1). doi:10.5281/zenodo.7535991

Examples

```
# list of temperature data for Gujranwala city
G <- mapply(function(low, high) list(c(low, high)),
                                       citytemp$Gujranwala_Low,
                                       citytemp$Gujranwala_High)
# Neutrosophic mean and standard deviation of temperature data for Gujranwala city
nmean(G)
nstd(G)
```

---

dioxin — *Average Daily Ingestion of Dioxin in Food Samples with Uncertainities*

Description

This dataset contains the estimated average daily ingestion of dioxins from food samples collected across Japan, including uncertainties in the values. Dioxins are toxic chemical compounds that pose significant health risks.

Usage

```
data("dioxin")
```

Format

The format is: List of 17 numeric interval values

Details

This data provides an analysis of dioxin intake and its potential health impacts including exposure levels from various food sources in Japan.

Source

The dataset was collected and monitored by the Ministry of Environment, Japan, as reported in their environmental statistics

References

Zahid Khan, Mohammed M. A. Almazah, Omalsad Hamood Odhah, and Huda M. Alshanbari (2022): Generalized Pareto Model: Properties and Applications in Neutrosophic Data Modeling. Mathematical Problems in Engineering, 2022(1). doi:10.1155/2022/3686968

Examples

```
data(dioxin)
 # Provide neutrosophic summary statistics
nsummary(dioxin)
```

`goldprice` *Gold Prices Across Six Indian Cities from February 2022 to January 2023*

Description

The dataset provides the monthly high and low prices (in rupees per gram) of 22-carat gold in six Indian cities: Chennai, Kolkatta,Bangal, .Data were collected from February 2022 to January 2023. This data can be used for neutrosophic statistical analysis of gold price trends.

Usage

```
data("goldprice")
```

Format

A data frame with 12 observations on the following 13 variables.

`Month` a character vector

`Chennai_Low` a numeric vector

`Chennai_High` a numeric vector

`Kolkatta_Low` a numeric vector

`Kolkatta_High` a numeric vector

`Bangalore_Low` a numeric vector

`Bangalore_High` a numeric vector

`Madurai_Low` a numeric vector

`Madurai_High` a numeric vector

`Hyderabad_Low` a numeric vector

`Hyderabad_High` a numeric vector

`Delhi_Low` a numeric vector

`Delhi_High` a numeric vector

Details

Monthly high and low gold prices in Chennai, Kolkatta, and Bangalore. These can be analyzed using neutrosophic statistical methods to evaluate variations and trends.

Source

Indian Daily Gold Prices Android App

References

Kala Raja Mohan, R. Narmada Devi, Nagadevi Bala Nagaram, T. Bharathi, and Suresh Rasappan (2023): Neutrosophic Statistical Analysis on Gold Rate. Neutrosophic Sets and Systems, 60(1). doi:10.5281/zenodo.7535991

Examples

```
#list of low and high gold price for Chennai City
ch<- mapply(function(low, high) list(c(low, high)),
                                       goldprice$Chennai_Low,
                                       goldprice$Chennai_High)

# neutrosophic coefficient of variation
ncv(ch)
```

`interval_add` *Interval addition of neutrosophic numbers*

Description

This function is used to find sum of more than one imprecise data values.

Usage

```
interval_add(data)
```

Arguments

`data`	List of neutrosophic numbers.This numeric list contains at least two neutrosophic intervals. Each interval value should contains two elements, lower and upper.If it crisp value is used,it is considered as an interval with same upper and lower value.

Value

A numeric vector of length 2,indicating a summed value of neutrosophic intervals

Author(s)

Zahid Khan

References

Moore, R. E. (1979): Methods and applications of interval analysis.SIAM. doi:10.1137/1.9781611970906

Smarandache, F (2022):Neutrosophic Statistics is an extension of Interval Statistics, while Plithogenic Statistics is the most general form of statistics(second version).Internation journal of neutrosophic science. 19(1),pp.148-165. doi:10.54216/IJNS.190111

See Also

interval_sub.

Examples

```
#Addition of to neutrosopic numbers
x=list(c(5,10),c(10,20))
interval_add(x)
```

---

interval_df *Interval conversion for neutrosophic numbers*

Description

Interval conversion for neutrosophic numbers

Usage

```
interval_df(data)
```

Arguments

data	data is a vector or a list of neutrosophic numbers

Value

Data frame of neutrosophic numbers.

Author(s)

Zahid Khan

References

Florentin Smarandache (2014): Introduction to Neutrosophic Statistics. ISBN: 9781599732749

Examples

```
# values are interval forms as required in neutrosophic data

data <- list(c(6, 6), c(2, 8), c(30,50), c(18, 24))

interval_df(data)
```

---

interval_div   *Division of the neutrosophic numbers*

Description

This function is used to find an interval division of the neutrosophic numbers

Usage

```
interval_div(data)
```

Arguments

data	List of neutrosophic numbers.This numeric list contains at least two neutrosophic intervals. Each interval value should contains two elements, lower and upper.If it crisp value is used,it is considered as an interval with same upper and lower value.

Value

A numeric vector of length 2,indicating a divided value of neutrosophic intervals

Author(s)

Zahid Khan

References

Moore, R. E. (1979): Methods and applications of interval analysis.SIAM. doi:10.1137/1.9781611970906. Smarandache, F (2022):Neutrosophic Statistics is an extension of Interval Statistics, while Plithogenic Statistics is the most general form of statistics(second version).Internation journal of neutrosophic science. 19(1),pp.148-165. doi:10.54216/IJNS.190111

See Also

interval_mul.

Examples

```
#Division of neutrosopic numbers
x=list(c(8,4),c(2,4))
interval_div(x)
```

`interval_mul` *Multiplication of the neutrosophic numbers*

Description

Interval multiplication of the neutrosophic numbers

Usage

```
interval_mul(data)
```

Arguments

`data`	List of neutrosophic numbers.This numeric list contains at least two neutrosophic intervals. Each interval value should contains two elements, lower and upper.If it crisp value is used,it is considered as an interval with same upper and lower value.

Value

A numeric vector of length 2,indicating a product value of neutrosophic intervals

Author(s)

Zahid Khan

References

Moore, R. E. (1979): Methods and applications of interval analysis.SIAM. doi:10.1137/1.9781611970906.
Smarandache, F (2022):Neutrosophic Statistics is an extension of Interval Statistics, while Plithogenic Statistics is the most general form of statistics(second version).Internation journal of neutrosophic science. 19(1),pp.148-165. doi:10.54216/IJNS.190111

See Also

`interval_sub`.

Examples

```
#Multiplication of the neutrosopic numbers
x=list(c(2,5),c(7,8))
interval_mul(x)
```

interval_sort *Sorting of the neutrosophic data*

Description

Sorting of neutrosophic values in the ascending order

Usage

```
interval_sort(data)
```

Arguments

`data`	data is a list of neutrosophic numbers

Value

List of intervals in asceding order.

Author(s)

Zahid Khan

References

Moore, R. E. (1979): Methods and applications of interval analysis.SIAM. doi:10.1137/1.9781611970906

See Also

`interval_add`,`interval_div`.

Examples

```
data <- list(c(5, 10), c(4,6), c(2, 3))
sort <- interval_sort(data)
print(sort)
```

`interval_sub` *This function is used to find substraction of more than one neutrosophic number*

Description

Interval subtraction of neutrosophic numbers.

Usage

```
interval_sub(data)
```

Arguments

`data`	List of neutrosophic numbers.This numeric list contains at least two neutrosophic intervals. Each interval value should contains two elements, lower and upper.If it crisp value is used,it is considered as an interval with same upper and lower value.

Value

A numeric vector of length 2,indicating a substracted value of neutrosophic intervals

Author(s)

Zahid Khan

References

Moore, R. E. (1979): Methods and applications of interval analysis.SIAM. doi:10.1137/1.9781611970906

Smarandache, F (2022):Neutrosophic Statistics is an extension of Interval Statistics, while Plithogenic Statistics is the most general form of statistics(second version).Internation journal of neutrosophic science. 19(1),pp.148-165. doi:10.54216/IJNS.190111.

See Also

`interval_add`.

Examples

```
#Substraction of two neutrosopic numbers
x=list(c(10,15),c(5,10))
interval_sub(x)
```

`ncv` *CV of the neutrosophic data*

Description

Neutrosophic coefficient of variation is an interval value of the neutrosphic numbers

Usage

```
ncv(data)
```

Arguments

`data`	data is a list of neutrosophic numbers

Value

Interval cv value.

Author(s)

Zahid Khan

References

Florentin Smarandache (2014): Introduction to Neutrosophic Statistics. ISBN: 9781599732749 Hussein Al-Marshadi, Ali and Aslam, Muhammad and Abdullah, Alharbey (2021): Uncertainty-Based Trimmed Coefficient of Variation with Application, Journal of Mathematics, 2021(1), pages 5511904. Wiley Online Library. doi:10.1155/2021/5511904

Kandemir, Hacer Şengül and Aral, Nazlım Deniz and Karakaş, Murat and Et, Mikail (2024): Neutrosophic Statistical Analysis of Temperatures of Cities in the Southeastern Anatolia Region of Turkey, Neutrosophic Systems with Applications, 14, pp. 50-59. doi:10.61356/j.nswa.2024.119

See Also

`nmean`,`nstd`.

Examples

```
data <- list(c(1, 2), c(4), c(2, 3))
mean <- nmean(data)
print(mean)
```

nexp *Neutrosophic Exponential Distribution with Characteristics*

Description

Computes various properties of the Neutrosophic Exponential distribution, including its density, cumulative distribution function (CDF), quantiles,random numbers with summary statistics,PDF and CDF plots of the distribution.

Usage

```
dnexp(x, rate_l, rate_u)

pnexp(q, rate_l, rate_u)

qnexp(p, rate_l, rate_u)

rnexp(n, rate_l, rate_u, stats=FALSE)

plot_npdfexp(rate_l, rate_u, x = c(0, 5),
                          color.fill = "lightblue", color.line = "blue",
                          title = "PDF Neutrosophic Exponential Distribution",
                          x.label = "x", y.label = "Density")

plot_ncdfexp(rate_l, rate_u, x = c(0, 5),
                          color.fill = "lightblue", color.line = "blue",
                          title = "CDF Neutrosophic Exponential Distribution",
                          x.label = "x", y.label = "Cumulative Probability")
```

Arguments

`x`	A numeric vector of observations for which the function will compute the corresponding distribution values.
`n`	number of random generated values
`rate_l`	A positive numeric value representing the lower bound of the rate parameter of the Neutrosophic Exponential distribution.
`rate_u`	A positive numeric value representing the upper bound of the rate parameter of the Neutrosophic Exponential distribution. This must be greater than or equal to `rate_l`.
`p`	A vector of probabilities for which the function will compute the corresponding quantile values
`q`	A vector of quantiles for which the function will compute the corresponding CDF values
`stats`	Logical; if `TRUE`, the function returns summary statistics of the generated random data (e.g., mean, standard deviation, quantiles, skewness, and kurtosis).

`color.fill`	A string representing the color for neutrosophic region.
`color.line`	A string representing the color used for the line of the PDF or CDF in the plots.
`title`	A string representing the title of the plot.
`x.label`	A string representing the label for the x-axis.
`y.label`	A string representing the label for the y-axis.

Details

The function computes various properties of the Neutrosophic Exponential distribution. Depending on the function variant used (e.g., density, CDF, quantiles), it will return the corresponding statistical measure for each input value of `x` in case of random number generation from Neutrosophic Exponential distribution. Moreover basic plots of PDF and CDF can be visualized.

Value

`dnexp` returns the PDF values

`pnexp` returns the lower tail CDF values.

`qnexp` returns the quantile values

`rnexp` return random values with summary statistics of the simulated data

`plot_npdfexp` returns PDF plot at given values of rate parameter

`plot_ncdfexp` returns CDF plot at given values of rate parameter

Author(s)

Zahid Khan

References

Duan, W., Q., Khan, Z., Gulistan, M., Khurshid, A. (2021). Neutrosophic Exponential Distribution: Modeling and Applications for Complex Data Analysis, Complexity, 2021, 1-8.doi:10.1155/2021/5970613

Examples

```
# random number with summary statistics
rnexp(10, rate_l=2, rate_u=4, stats = TRUE)

# PDF values
x <- c(1, 2, 3)  # Values at which to evaluate the PDF
rate_l <- 0.5
rate_u <- 2.0
dnexp(x, rate_l, rate_u)

# CDF values
q <- c(2, 3, 3.5)
rate_l <- 0.5
rate_u <- 2.0
pnexp(q, rate_l, rate_u)
```

```
# Quantile values

p <- 0.5    # Probability at which to evaluate the quantile
rate_l <- 0.5
rate_u <- 2.0
qnexp(p, rate_l, rate_u)

# PDF PLOT

plot_npdfexp(rate_l = 1, rate_u = 2, x = c(0, 5))

# CDF PLOT

 plot_ncdfexp(rate_l = 1, rate_u = 2, x = c(0, 5))
```

`ngam` *Neutrosophic Gamma Distribution with Characteristics*

Description

Computes various properties of the Neutrosophic Gamma distribution, including its density, cumulative distribution function (CDF), quantiles,random numbers with summary statistics,PDF and CDF plots of the distribution.

Usage

```
dngam(x, scale_l, scale_u, shape_l, shape_u)

pngam(q, scale_l, scale_u, shape_l, shape_u)

qngam(p, scale_l, scale_u, shape_l, shape_u)

rngam(n, scale_l, scale_u, shape_l, shape_u, stats = FALSE)

plot_npdfgam(scale_l, scale_u, shape_l, shape_u, x = c(0, 5),
                          color.fill = "lightblue", color.line = "blue",
                          title = "PDF Neutrosophic Gamma Distribution",
                          x.label = "x", y.label = "Density")

plot_ncdfgam(scale_l, scale_u, shape_l, shape_u, x = c(0, 5),
                          color.fill = "lightblue", color.line = "blue",
                          title = "CDF Neutrosophic Gamma Distribution",
                          x.label = "x", y.label = "Cumulative Probability")
```

Arguments

`x` A numeric vector of observations for which the function will compute the corresponding distribution values.

n	number of random generated values
scale_l	A positive numeric value representing the lower bound of the scale parameter of the Neutrosophic Gamma distribution.
scale_u	A positive numeric value representing the upper bound of the scale parameter of the Neutrosophic Gamma distribution. This must be greater than or equal to rate_l.
shape_l	A positive numeric value representing the lower bound of the shape parameter of the Neutrosophic Gamma distribution.
shape_u	A positive numeric value representing the upper bound of the shape parameter of the Neutrosophic Gamma distribution.
p	A vector of probabilities for which the function will compute the corresponding quantile values
q	A vector of quantiles for which the function will compute the corresponding CDF values
stats	Logical; if TRUE, the function returns summary statistics of the generated random data (e.g., mean, standard deviation, quantiles, skewness, and kurtosis).
color.fill	A string representing the color for neutrosophic region.
color.line	A string representing the color used for the line of the PDF or CDF in the plots.
title	A string representing the title of the plot.
x.label	A string representing the label for the x-axis.
y.label	A string representing the label for the y-axis.

Details

The function computes various properties of the Neutrosophic Gamma distribution. Depending on the function variant used (e.g., density, CDF, quantiles), it will return the corresponding statistical measure for each input value of x in case of random number generation from Neutrosophic Gamma distribution. Moreover basic plots of PDF and CDF can be visualized.

Value

dngam returns the PDF values

pngam returns the lower tail CDF values.

qngam returns the quantile values

rngam return random values with summary statistics of the simulated data

plot_npdfgam returns PDF plot at given values of distributional parameters

plot_ncdfgam returns CDF plot at given values of distributional parameters

Author(s)

Zahid Khan

References

Khan Z, Al-Bossly A, Almazah M, Alduais FS. (2021). On Statistical Development of Neutrosophic Gamma Distribution with Applications to Complex Data Analysis, Complexity, 2021, 1-8.doi:10.1155/2021/3701236

Examples

```
# random number Generation with summary statistics

rngam(10, scale_l = 2, scale_u = 4, shape_l = 1, shape_u = 1, stats = TRUE)

# PDF values
x <- 2
scale_l <- 1
scale_u <- 2.0
shape_l<-0.5
shape_u<-2
dngam(x, scale_l, scale_u, shape_l, shape_u)

# CDF values
q <- 1.5
scale_l <- 1
scale_u <- 2.0
shape_l<-0.5
shape_u<-2.0
pngam(q, scale_l, scale_u, shape_l, shape_u)

# Quantile values

p <- 0.5
scale_l <- 1
scale_u <- 2.0
shape_l<-0.5
shape_u<-2
qngam(p, scale_l, scale_u, shape_l, shape_u)

# PDF PLOT
scale_l <- 1
scale_u <- 1
shape_l<-2
shape_u<-3
plot_npdfgam(scale_l, scale_u, shape_l, shape_u, x = c(0, 5))

# CDF PLOT
scale_l <- 1
scale_u <- 1
shape_l<-2
shape_u<-3
plot_ncdfgam(scale_l, scale_u, shape_l, shape_u, x = c(0, 5))
```

nkur — *Neutrosophic Coefficient of Kurtosis*

Description

Neutrosophic kurtosis is an interval value that measures the flatness and peakedness of neutrosophic data using the method of moments

Usage

```
nkur(data)
```

Arguments

`data`	data is a list of neutrosophic numbers

Value

An interval value of coefficeint of Kurtosis.

Author(s)

Zahid Khan

References

Florentin Smarandache (2014): Introduction to Neutrosophic Statistics. ISBN: 9781599732749

Aslam, Muhammad (2021): A study on skewness and kurtosis estimators of wind speed distribution under indeterminacy, Theoretical and Applied Climatology, 143(3), pp. 1227-1234. doi:10.1007/s00704-020-03509-5

See Also

`nsk`.

Examples

```
data <- list(c(1, 2), c(4), c(2, 3),c(6,8),c(12,20),c(20,30))
k <- nkur(data)
print(k)
```

`nlap` *Neutrosophic Laplace Distribution with Characteristics*

Description

Computes various properties of the Neutrosophic Laplace distribution, including its density, cumulative distribution function (CDF), quantiles,random numbers with summary statistics,PDF and CDF plots of the distribution.

Usage

```
dnlap(x, scale_l, scale_u, location_l, location_u)

pnlap(q, scale_l, scale_u, location_l, location_u)

qnlap(p, scale_l, scale_u, location_l, location_u)

rnlap(n, scale_l, scale_u, location_l, location_u, stats = FALSE)

plot_npdflap(scale_l, scale_u, location_l, location_u, x = c(0, 5),
                         color.fill = "lightblue", color.line = "blue",
                         title = "PDF Neutrosophic Laplace Distribution",
                         x.label = "x", y.label = "Density")

plot_ncdflap(scale_l, scale_u, location_l, location_u, x = c(0, 5),
                         color.fill = "lightblue", color.line = "blue",
                         title = "CDF Neutrosophic Laplace Distribution",
                         x.label = "x", y.label = "Cumulative Probability")
```

Arguments

`x`	A numeric vector of observations for which the function will compute the corresponding distribution values.
`n`	number of random generated values
`scale_l`	A positive numeric value representing the lower bound of the scale parameter of the Neutrosophic Laplace distribution.
`scale_u`	A positive numeric value representing the upper bound of the scale parameter of the Neutrosophic Laplace distribution. This must be greater than or equal to `rate_l`.
`location_l`	A positive numeric value representing the lower bound of the location parameter of the Neutrosophic Laplace distribution.
`location_u`	A positive numeric value representing the upper bound of the location parameter of the Neutrosophic Laplace distribution.
`p`	A vector of probabilities for which the function will compute the corresponding quantile values

`q`	A vector of quantiles for which the function will compute the corresponding CDF values
`stats`	Logical; if `TRUE`, the function returns summary statistics of the generated random data (e.g., mean, standard deviation, quantiles, skewness, and kurtosis).
`color.fill`	A string representing the color for neutrosophic region.
`color.line`	A string representing the color used for the line of the PDF or CDF in the plots.
`title`	A string representing the title of the plot.
`x.label`	A string representing the label for the x-axis.
`y.label`	A string representing the label for the y-axis.

Details

The function computes various properties of the Neutrosophic Laplace distribution. Depending on the function variant used (e.g., density, CDF, quantiles), it will return the corresponding statistical measure for each input value of `x` in case of random number generation from Neutrosophic Laplace distribution. Moreover basic plots of PDF and CDF can be visualized.

Value

`dnlap` returns the PDF values

`pnlap` returns the lower tail CDF values.

`qnlap` returns the quantile values

`rnlap` return random values with summary statistics of the simulated data

`plot_npdflap` returns PDF plot at given values of distributional parameters

`plot_ncdflap` returns CDF plot at given values of distributional parameters

Author(s)

Zahid Khan

References

Musa A, Khan Z. (2024). Neutrosophic Laplace Distribution with Properties and Applications in Decision Making. International Journal of Neutrosophic Science, 2024, 73-84. doi:10.54216/IJNS.230106.

Examples

```
# random number Generation with summary statistics

rnlap(10, scale_l = 2, scale_u = 4, location_l = 1, location_u = 1, stats = TRUE)

# PDF values
x <- 2
scale_l <- 0.5
scale_u <- 1
location_l<-0
location_u<-0
```

```
dnlap(x, scale_l, scale_u, location_l, location_u)

# CDF values
q <- 1.5
scale_l <- 1
scale_u <- 2
location_l<-0
location_u<-0
pnlap(q, scale_l, scale_u, location_l, location_u)

# Quantile values

p <- 0.1
scale_l <- 0.5
scale_u <- 0.7
location_l<-0
location_u<-0
qnlap(p, scale_l, scale_u, location_l, location_u)

# PDF PLOT
scale_l <- 0.5
scale_u <- 1
location_l<-0
location_u<-0
plot_npdflap(scale_l, scale_u, location_l, location_u, x = c(-5, 5))

# CDF PLOT
scale_l <- 0.5
scale_u <- 1
location_l<-0
location_u<-0
plot_ncdflap(scale_l, scale_u, location_l, location_u, x = c(-5, 5))
```

`nmean` *Mean of the neutrosophic data*

Description

Neutrosophic mean is an interval value of the neutrosphic numbers

Usage

```
nmean(data)
```

Arguments

`data`	data is a list of neutrosophic numbers

Value

Interval mean value.

Author(s)

Zahid Khan

References

Florentin Smarandache (2014): Introduction to Neutrosophic Statistics. ISBN: 9781599732749

See Also

`interval_add`,`interval_div`.

Examples

```
data <- list(c(1, 2), c(4), c(2, 3))
mean <- nmean(data)
print(mean)
```

`nmedian` *Median of the neutrosophic data*

Description

Finding the median of the neutrosophic interval values

Usage

```
nmedian(data)
```

Arguments

`data`	list of neutrosophic numbers

Value

interval median value.

Author(s)

Zahid Khan

References

Florentin Smarandache (2014): Introduction to Neutrosophic Statistics. ISBN: 9781599732749

See Also

interval_sort.

Examples

```
data <- list(c(5, 10), c(4,6), c(2, 3))
med <- nmedian(data)
print(med)
```

---

nnorm *Neutrosophic Normal Distribution with Characteristics*

Description

Computes various properties of the Neutrosophic Normal distribution, including its density, cumulative distribution function (CDF), quantiles,random numbers with summary statistics,PDF and CDF plots of the distribution.

Usage

```
dnnorm(x, sd_l, sd_u, mean_l, mean_u)

pnnorm(q, sd_l, sd_u, mean_l, mean_u)

qnnorm(p, sd_l, sd_u, mean_l, mean_u)

rnnorm(n, sd_l, sd_u, mean_l, mean_u, stats = FALSE)

plot_npdfnorm(sd_l, sd_u, mean_l, mean_u, x = c(0, 5),
                        color.fill = "lightblue", color.line = "blue",
                        title = "PDF Neutrosophic Normal Distribution",
                        x.label = "x", y.label = "Density")

plot_ncdfnorm(sd_l, sd_u, mean_l, mean_u, x = c(0, 5),
                        color.fill = "lightblue", color.line = "blue",
                        title = "CDF Neutrosophic Normal Distribution",
                        x.label = "x", y.label = "Cumulative Probability")
```

Arguments

x	A numeric vector of observations for which the function will compute the corresponding distribution values.
n	number of random generated values
sd_l	A positive numeric value representing the lower bound of the sd parameter of the Neutrosophic Normal distribution.

`sd_u`	A positive numeric value representing the upper bound of the sd parameter of the Neutrosophic Normal distribution. This must be greater than or equal to `rate_l`.
`mean_l`	A numeric value representing the lower bound of the mean parameter of the Neutrosophic Normal distribution.
`mean_u`	A numeric value representing the upper bound of the mean parameter of the Neutrosophic Normal distribution.
`p`	A vector of probabilities for which the function will compute the corresponding quantile values
`q`	A vector of quantiles for which the function will compute the corresponding CDF values
`stats`	Logical; if `TRUE`, the function returns summary statistics of the generated random data (e.g., mean, standard deviation, quantiles, skewness, and kurtosis).
`color.fill`	A string representing the color for neutrosophic region.
`color.line`	A string representing the color used for the line of the PDF or CDF in the plots.
`title`	A string representing the title of the plot.
`x.label`	A string representing the label for the x-axis.
`y.label`	A string representing the label for the y-axis.

Details

The function computes various properties of the Neutrosophic Normal distribution. Depending on the function variant used (e.g., density, CDF, quantiles), it will return the corresponding statistical measure for each input value of `x` in case of random number generation from Neutrosophic Normal distribution. Moreover basic plots of PDF and CDF can be visualized.

Value

`dnnorm` returns the PDF values

`pnnorm` returns the lower tail CDF values.

`qnnorm` returns the quantile values

`rnnorm` return random values with summary statistics of the simulated data

`plot_npdfnorm` returns PDF plot at given values of distributional parameters

`plot_ncdfnorm` returns CDF plot at given values of distributional parameters

Author(s)

Zahid Khan

References

Patro SK, Smarandache F. (2016). The neutrosophic statistical distribution, more problems, more solutions. Neutrosophic Sets and Systems, 12, 73-79.doi:10.5281/zenodo.571153

Examples

```
# random number Generation with summary statistics

rnnorm(10, sd_l = 2, sd_u = 4, mean_l = 1, mean_u = 1, stats = TRUE)

# PDF values
x <- 2
sd_l <- 0.5
sd_u <- 1
mean_l<-0
mean_u<-0
dnnorm(x, sd_l, sd_u, mean_l, mean_u)

# CDF values
q <- 1.5
sd_l <- 1
sd_u <- 2
mean_l<-0
mean_u<-0
pnnorm(q, sd_l, sd_u, mean_l, mean_u)

# Quantile values

p <- 0.1
sd_l <- 0.5
sd_u <- 0.7
mean_l<-0
mean_u<-0
qnnorm(p, sd_l, sd_u, mean_l, mean_u)

# PDF PLOT
sd_l <- 0.5
sd_u <- 1
mean_l<-0
mean_u<-0
plot_npdfnorm(sd_l, sd_u, mean_l, mean_u, x = c(-5, 5))

# CDF PLOT
sd_l <- 0.5
sd_u <- 1
mean_l<-0
mean_u<-0
plot_ncdfnorm(sd_l, sd_u, mean_l, mean_u, x = c(-5, 5))
```

---

nquant *Quantiles of the neutrosophic data*

Description

Neutrosophic quantiles provide three quantile interval values of the neutrosophic data

Usage

```
nquant(data)
```

Arguments

data	A list of neutrosophic numbers.Each neutrosophic number is represented by an interval.

Value

A named list containing the first, second and third quantile interval values where each quantile is represented as an interval value

Author(s)

Zahid Khan

References

Florentin Smarandache (2014): Introduction to Neutrosophic Statistics. ISBN: 9781599732749

See Also

nmedian.

Examples

```
data <- list(c(5, 10), c(4,6), c(2, 3),c(4,8))
q <- nquant(data)
print(q)
```

---

nray *Neutrosophic Rayleigh Distribution with Characteristics*

Description

Computes various properties of the Neutrosophic Rayleigh distribution, including its density, cumulative distribution function (CDF), quantiles,random numbers with summary statistics,PDF and CDF plots of the distribution.

Usage

```
dnray(x, scale_l, scale_u)

pnray(q, scale_l, scale_u)

qnray(p, scale_l, scale_u)

rnray(n, scale_l, scale_u, stats=FALSE)

plot_npdfray(scale_l, scale_u, x = c(0, 5),color.fill = "lightblue", color.line = "blue",
                         title = "PDF Neutrosophic Rayleigh Distribution",
                         x.label = "x", y.label = "Density")

plot_ncdfray(scale_l, scale_u, x = c(0, 5),color.fill = "lightblue", color.line = "blue",
                         title = "CDF Neutrosophic Rayleigh Distribution",
                         x.label = "x", y.label = "Cumulative Probability")
```

Arguments

`x`	A numeric vector of observations for which the function will compute the corresponding distribution values.
`n`	number of random generated values
`scale_l`	A positive numeric value representing the lower bound of the scale parameter of the Neutrosophic Rayleigh distribution.
`scale_u`	A positive numeric value representing the upper bound of the scale parameter of the Neutrosophic Rayleigh distribution. This must be greater than or equal to `scale_l`.
`p`	A vector of probabilities for which the function will compute the corresponding quantile values
`q`	A vector of quantiles for which the function will compute the corresponding CDF values
`stats`	Logical; if `TRUE`, the function returns summary statistics of the generated random data (e.g., mean, standard deviation, quantiles, skewness, and kurtosis).
`color.fill`	A string representing the color for neutrosophic region.
`color.line`	A string representing the color used for the line of the PDF or CDF in the plots.
`title`	A string representing the title of the plot.
`x.label`	A string representing the label for the x-axis.
`y.label`	A string representing the label for the y-axis.

Details

The function computes various properties of the Neutrosophic Rayleigh distribution. Depending on the function variant used (e.g., density, CDF, quantiles), it will return the corresponding statistical measure for each input value of `x` in case of random number generation from Neutrosophic Rayleigh distribution. Moreover basic plots of PDF and CDF can be visualized.

Value

`dnray` returns the PDF values

`pnray` returns the lower tail CDF values

`qnray` returns the quantile values

`rnray` return random values with summary statistics of the simulated data

`plot_npdfexp` returns PDF plot at given values of scale parameter

`plot_ncdfexp` returns CDF plot at given values of scale parameter

Author(s)

Zahid Khan

References

Khan, Z., Gulistan, M., Kausar, N., Park, C. (2021). Neutrosophic Rayleigh Model With Some Basic Characteristics and Engineering Applications. IEEE Access, 9, 71277-71283. doi:10.1109/ACCESS.2021.3078150.

Examples

```
# random number with summary statistics
rnray(10, scale_l=2, scale_u=4, stats = TRUE)

# PDF values
x <- c(1, 2, 3)  # Values at which to evaluate the PDF
scale_l <- 0.5
scale_u <- 2.0
dnray(x, scale_l, scale_u)

# CDF values
q <- c(2, 3, 3.5)
scale_l <- 0.5
scale_u <- 2.0
pnray(q, scale_l, scale_u)

# Quantile values

p <- 0.5    # Probability at which to evaluate the quantile
scale_l <- 0.5
scale_u <- 2.0
qnray(p, scale_l, scale_u)

# PDF PLOT

scale_l <- 0.5  # Minimum rate
scale_u <- 2  # Maximum rate
plot_npdfray(scale_l, scale_u, x = c(0, 3))

# CDF PLOT

scale_l <- 0.5  # Minimum rate
```

```
scale_u <- 2.0  # Maximum rate
plot_ncdfray(scale_l, scale_u, x = c(0, 3),title = "")
```

---

nsk *Neutrosophic Pearson Coefficient of Skewness*

Description

Neutrosophic skewness is imprecise value that measures the asymmetery of neutrosophic data using the method of moments

Usage

```
nsk(data)
```

Arguments

data	data is a list of neutrosophic numbers

Value

An interval value of Pearson coefficeint of skewness.

Author(s)

Zahid Khan

References

Florentin Smarandache (2014): Introduction to Neutrosophic Statistics. ISBN: 9781599732749
Aslam, Muhammad (2021): A study on skewness and kurtosis estimators of wind speed distribution under indeterminacy, Theoretical and Applied Climatology, 143(3), pp. 1227-1234.doi:10.1007/s00704-020-03509-5

See Also

nmean,nstd.

Examples

```
data <- list(c(1, 2), c(4), c(2, 3),c(6,8),c(12,20))
s <- nsk(data)
print(s)
```

nstd — *Standard deviation of the neutrosophic data*

Description

Neutrosophic standard deviation is an interval value of the neutrosphic numbers

Usage

```
nstd(data)
```

Arguments

data	data is a list of neutrosophic numbers

Value

Interval dispersion value.

Author(s)

Zahid Khan

References

Florentin Smarandache (2014): Introduction to Neutrosophic Statistics. ISBN: 9781599732749

See Also

nmean,interval_add.

Examples

```
data <- list(6, c(2, 5), 30, c(18, 24))
sd <- nstd(data)
print(sd)
```

nsummary *summary of the neutrosophic data*

Description

Descriptive summary of the neutrosphic numbers

Usage

```
nsummary(data)
```

Arguments

`data`	data is a list of neutrosophic numbers

Value

Data frame of descriptive neutrosophic statistics.

Author(s)

Zahid Khan

References

Florentin Smarandache (2014): Introduction to Neutrosophic Statistics. ISBN: 9781599732749

See Also

`interval_add`,`interval_div`.

Examples

```
data <- list(c(1, 2), c(4), c(2, 3),c(5,11),c(4,8),c(20,25))
s <- nsummary(data)
print(s)
```

nvar *Variance of the neutrosophic data*

Description

Neutrosophic variance is an interval value of the neutrosphic numbers

Usage

```
nvar(data)
```

Arguments

`data`	data is a list of neutrosophic numbers

Value

Interval dispersion value.

Author(s)

Zahid Khan

References

Florentin Smarandache (2014): Introduction to Neutrosophic Statistics. ISBN: 9781599732749

See Also

nmean,interval_add.

Examples

```
data <- list(6, c(2, 5), 30, c(18, 24))
variance <- nvar(data)
print(variance)
```

`nwbl` *Neutrosophic Weibull Distribution with Characteristics*

Description

Computes various properties of the Neutrosophic Weibull distribution, including its density, cumulative distribution function (CDF), quantiles,random numbers with summary statistics,PDF and CDF plots of the distribution.

Usage

```
dnwbl(x, scale_l, scale_u, shape_l, shape_u)

pnwbl(q, scale_l, scale_u, shape_l, shape_u)

qnwbl(p, scale_l, scale_u, shape_l, shape_u)

rnwbl(n, scale_l, scale_u, shape_l, shape_u, stats = FALSE)

plot_npdfwbl(scale_l, scale_u, shape_l, shape_u, x = c(0, 5),
                         color.fill = "lightblue", color.line = "blue",
                         title = "PDF Neutrosophic Weibull Distribution",
                         x.label = "x", y.label = "Density")

plot_ncdfwbl(scale_l, scale_u, shape_l, shape_u, x = c(0, 5),
                         color.fill = "lightblue", color.line = "blue",
                         title = "CDF Neutrosophic Weibull Distribution",
                         x.label = "x", y.label = "Cumulative Probability")
```

Arguments

`x`	A numeric vector of observations for which the function will compute the corresponding distribution values.
`n`	number of random generated values
`scale_l`	A positive numeric value representing the lower bound of the scale parameter of the Neutrosophic Weibull distribution.
`scale_u`	A positive numeric value representing the upper bound of the scale parameter of the Neutrosophic Weibull distribution. This must be greater than or equal to `rate_l`.
`shape_l`	A positive numeric value representing the lower bound of the shape parameter of the Neutrosophic Weibull distribution.
`shape_u`	A positive numeric value representing the upper bound of the shape parameter of the Neutrosophic Weibull distribution.
`p`	A vector of probabilities for which the function will compute the corresponding quantile values

q	A vector of quantiles for which the function will compute the corresponding CDF values
stats	Logical; if TRUE, the function returns summary statistics of the generated random data (e.g., mean, standard deviation, quantiles, skewness, and kurtosis).
color.fill	A string representing the color for neutrosophic region.
color.line	A string representing the color used for the line of the PDF or CDF in the plots.
title	A string representing the title of the plot.
x.label	A string representing the label for the x-axis.
y.label	A string representing the label for the y-axis.

Details

The function computes various properties of the Neutrosophic Weibull distribution. Depending on the function variant used (e.g., density, CDF, quantiles), it will return the corresponding statistical measure for each input value of x in case of random number generation from Neutrosophic Weibull distribution. Moreover basic plots of PDF and CDF can be visualized.

Value

dnwbl returns the PDF values

pnwbl returns the lower tail CDF values.

qnwbl returns the quantile values

rnwbl return random values with summary statistics of the simulated data

plot_npdfwbl returns PDF plot at given values of distributional parameters

plot_ncdfwbl returns CDF plot at given values of distributional parameters

Author(s)

Zahid Khan

References

Khan, Kahid; Gulistan, Muhammad; Lane-Krebs, Katrina; Salem, Sultan (2023). Neutrophasic Weibull model with applications to survival studies. CQUniversity, 25-42.doi:10.1016/B978-0-323-99456-9.00007-6

Examples

```
# random number Generation with summary statistics

rnwbl(5, scale_l = 2, scale_u = 4, shape_l = 1, shape_u = 1, stats = TRUE)

# PDF values
x <- 2
scale_l <- 1
scale_u <- 2.0
shape_l<-0.5
```

```
shape_u<-2
dnwbl(x, scale_l, scale_u, shape_l, shape_u)

# CDF values
q <- 1.5
scale_l <- 1
scale_u <- 2.0
shape_l<-0.5
shape_u<-2.0
pnwbl(q, scale_l, scale_u, shape_l, shape_u)

# Quantile values

p <- 0.5
scale_l <- 1
scale_u <- 2.0
shape_l<-0.5
shape_u<-2
qnwbl(p, scale_l, scale_u, shape_l, shape_u)

# PDF PLOT
scale_l <- 1
scale_u <- 1
shape_l<-2
shape_u<-3
plot_npdfwbl(scale_l, scale_u, shape_l, shape_u, x = c(0, 5))

# CDF PLOT
scale_l <- 1
scale_u <- 1
shape_l<-2
shape_u<-3
plot_ncdfwbl(scale_l, scale_u, shape_l, shape_u, x = c(0, 5))
```

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