lmomco–version 0.3

January 31, 2006

R topics documented:

Introduction *Introduction to R library lmoments*

Description

This manual documents the R-software package **lmomco**. The **lmomco** package implements the **statistical theory of L-moments** including L-moment estimation (lmom.ub, lmom2pwm), Probability-Weighted Moment estimation (pwm.ub, pwm.pp, pwm.gev), parameter estimation for numerous familiar and not-so-familiar distributions (see following paragraph), and L-moment estimation for the same distributions from the parameters (lmom2par). In words, L-moments are derived from the expectations of order statistics and are linear with respect to the probability-weighted moments. The linearity between L-moments and Probability-Weighted Moments means that procedures base on one are equivalent to the other. L-moments are directly analogous to the well-known product moments; however, L-moments have many advantages including unbiasedness, robustness, and consistency with respect to the conventional product (central) moments (mean, standard deviation, skew, kurtosis, ...). L-moment have particular internal relations to themselves and boundness (see are.lmom.valid). This package is oriented around the FORTRAN algorithms of J.R.M. Hosking, and the nomenclature for many of the functions parallels that of the Hosking library. Extensions are made. Additionally, recent developments by Robert Serfling and Peng Xiao have extended L-moments into multivariate space–**the L-comoments**. The sample L-comoments (Lcomoment.Lk12) are implemented here for an unlimited number of random variables and moment order value. The L-comoments are considered experimental, but the diagonal of the L-comoment matrix (Lcomoment.matrix) produces conventional L-moments (lmom.ub) of the corresponding order.

At present (2006), 11 distributions (all univariate) are supported for parameter estimation using L-moments (parCCC, such as parexp), L-moment estimation using parameters (lmomCCC, such as lmomexp), cumulative distribution function (nonexceedance probability as a function of the variable), and quantile distribution function (variable as a function of nonexceedance probability). A dispatcher for parameter estimation from the L-moments is lmom2par. A dispatcher for L-moment estimation from the parameters is par2lmom. The cumulative distribution functions are cdfCCC, such as cdfexp; a dispatcher to the cumulative distribution functions is par2cdf. The quantile functions are quaCCC, such as quaexp; a dispatcher to the quantile functions is par2qua. The distributions supported are the Exponential, Gamma, Generalized Extreme Value, Generalized Logistic, Generalized Normal, Generalized Pareto, Gumbel, Kappa, Normal, Pearson Type III, and Wakeby. Some of these distributions (Exponential, Gamma, and Normal) have functional implementation within the standard R-package distribution. However, as this package in part mirrors existing FORTRAN libraries in wide spread use by the L-moment user-community (environmental and hydrologic sciences–at least those familiar to the author), these three distributions are implemented here in a parallel function context. It is important to note that R functions are used for these three distributions. Additional univariate distributions that are implemented are: Cauchy (quantile and cumulative distributions functions only) and Generalized Lambda (quantile function only); the L-moments to parameters and parameters to L-moments are not yet implemented. The 13 distributions are referred to by a three-character syntax (denoted as CCC in the documentation):

cau = Cauchy distribution (two parameters)–only quacau and cdfcau are implemented.

exp = Exponential distribution (two parameters)

gam = Gamma distribution (two parameters)

gev = Generalized Extreme Value distribution (three parameters)

gld = Generalized Lambda distribution (four parameters)–only quagld is implemented.

`glo` = Generalized Logistic distribution (three parameters)

`gno` = Generalized Normal (log-Normal) distribution (three parameters)

`gpa` = Generalized Pareto distribution (three parameters)

`gum` = Gumbel distribution (two parameters)

`kap` = Kappa distribution (four parameters)

`nor` = Normal distribution (two parameters)

`pe3` = Pearson Type III distribution (three parameters)

`wak` = Wakeby distribution (five parameters)

Parameters for the distribution are placed into a particular object format (see `vec2par`, `lmom2par`, or `parexp`). The parameter object (simply an R `list`) in turn can be passed as an argument to the distribution functions. A broader intent of this package is to support modular code design when users are heavily involved in distributional analysis. Therefore, this package contains a number of ancillary functions such as `are.par.valid` or `is.CCC`, where `CCC` is the three character syntax as previously shown to assist users in building sophisticated tools in R.

This package also supports the construction of L-moment ratio diagrams (`lmrdia` and `plotlmrdia`)–namely, the construction of the L-skew and L-kurtosis diagram. On the diagram and the theoretical trajectories of most of the aforementioned distributions. These diagrams are difficult to explain here, but are well documented in the literature (`lmom.references`).

Several other functions are available and might be useful in testing or other circumstances. The `lmom.diff` function computes the difference between the L-moments derived from a parameterized distribution and the L-moments as computed from the data. From the author's experience, construction of "magnitude and frequency curves" (variable as function of nonexceedance probability) is commonly required. Therefore, `freq.curve.CCC` are available for ease of use. There also is a `freq.curve.all` function that computes the frequency curve for all the distributions given an L-moment object (not inclusive of the `gld` distribution). The curves require vectors of nonexceedance probabilities (see `nonexceeds`). Related to nonexceedance probabilities, note that for this documentation nonexceedance probability is shown as $0 \leq F \leq 1$; however, some distributions might not be valid at $F = 0$ or $F = 1$. Finally, the functions `lmom.test.all`, which dispatches to distribution-specific functions following the `lmom.test.CCC` naming convention and provides user-level output to help evaluate the algorithms of this package.

The examples below demonstrate application of the package for the analysis of a sample. The L-moments of the data are computed. In turn, the Kappa and Normal distributions are each fit to the L-moments. The frequency curve (quantile as function of nonexceedance probability) for each distribution is plotted. The examples conclude with the computation of the 2nd-order L-comoment matrix of two nonindependent samples.

Author(s)

W.H. Asquith

Examples

```
# One has the following peak streamflow values in cubic meters per second
data <- c(123,2250,543,178,67,5100,248,1500,342,329,543,980,1020,4502,3406,856,297)
# Compute the unbiased L-moments of the data--high L-skew.
# This data is clearly not Normally distributed.
lmr  <- lmom.ub(data)
# One method of parameter estimation for a Kappa distribution
Kappapar  <- lmom2par(lmr,type='kap')
# Another method of parameter estimation for Normal distribution
```

```
Normalpar <- parnor(lmr)
# Vector of useful nonexceedance probabilities
F  <- nonexceeds()
# Generate Kappa frequency curve
Qk <- freq.curve.kap(nonexceeds(),Kappapar)
# Generate Normal frequeny curve
Qn <- freq.curve.nor(nonexceeds(),Normalpar)
# Plot them up
plot(F,Qk,type="n",ylim=c(-6000,24000))
lines(F,Qk)
lines(F,Qn,col=2)

X1 <- data
# Generate some related data
X2 <- abs(rnorm(length(data)))*data
L2 <- Lcomoment.matrix(data.frame(RandomVariable1=X1,AnotherRandomVariable=X2),k=2)
L2
# Compute the convential L-moments of variable 1 and 2
X1lmr <- lmom.ub(X1)
X2lmr <- lmom.ub(X2)
# Show that the diagonal of the Lcomoment matrix equals the
# conventional moments of same order (2nd order in this case).
print(c(X1lmr$L2,L2$matrix[1,1]))
print(c(X2lmr$L2,L2$matrix[2,2]))
# Compute the L-correlation values
Lrho <- Lcomoment.correlation(L2)
Lrho
# Compare the off-diagonal terms to the conventional
# correlation coefficient. The off-diagonal terms will
# not be equal or equal in value to the conventional
# correlation coefficient.
cor(X1,X2)
```

---

are.lmom.valid *Are the L-moments valid*

Description

The second through fifth order L-moments are perhaps the most common in analysis situations. These L-moments have particular constraints on magnitudes and relation to each other. This function evaluates and L-moment object whether: L-scale ($\lambda_2 > 0$), L-skew ($-1 < \tau_3 < 1$), L-kurtosis ($0.25(5\tau_3^2 - 1) < \tau_4 < 1$), and $\tau_5 < 1$.

Usage

```
are.lmom.valid(lmom)
```

Arguments

lmom	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

TRUE	L-moments are valid.
FALSE	L-moments are not valid.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `pwm2lmom`

Examples

```
lmr <- lmom.ub(rnorm(20))
if(are.lmom.valid(lmr)) print("They are.")
```

`are.parcau.valid` *Are the Distribution Parameters Consistent with the Cauchy Distribution*

Description

The distribution parameter object returned by functions of this package such as by `vec2par` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfcau` and `quacau`) require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively.

Usage

```
are.parcau.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `vec2par`.

Value

`TRUE`	If the parameters are `cau` consistent.
`FALSE`	If the parameters are not `cau` consistent.

Note

This function calls `is.cau` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Gilchirst, W.G., 2000, Statistical modeling with quantile functions: Chapman and Hall/CRC, Boca Raton, FL.

See Also

is.cau

Examples

```
para <- vec2par(c(12,12),type='cau')
if(are.parcau.valid(para)) Q <- quacau(0.5,para)
```

---

are.parexp.valid *Are the Distribution Parameters Consistent with the Exponential Distribution*

Description

The distribution parameter object returned by functions of this package such as by `parexp` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfexp`, `quaexp`, and `lmomexp` require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively. These functions internally use the `are.parexp.valid` function. The FORTRAN source code of Hosking provides the basis for the function.

Usage

```
are.parexp.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `parexp`.

Value

`TRUE`	If the parameters are `exp` consistent.
`FALSE`	If the parameters are not `exp` consistent.

Note

This function calls `is.exp` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`is.exp`

Examples

```
para <- parexp(lmom.ub(c(123,34,4,654,37,78)))
if(are.parexp.valid(para)) Q <- quaexp(0.5,para)
```

`are.pargam.valid` *Are the Distribution Parameters Consistent with the Gamma Distribution*

Description

The distribution parameter object returned by functions of this package such as by `pargam` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfgam`, `quagam`, and `lmomgam` require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively. These functions internally use the `are.pargam.valid` function. The FORTRAN source code of Hosking provides the basis for the function.

Usage

```
are.pargam.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `pargam`.

Value

`TRUE`	If the parameters are `gam` consistent.
`FALSE`	If the parameters are not `gam` consistent.

Note

This function calls `is.gam` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`is.gam`

Examples

```
para <- pargam(lmom.ub(c(123,34,4,654,37,78)))
if(are.pargam.valid(para)) Q <- quagam(0.5,para)
```

`are.pargev.valid` *Are the Distribution Parameters Consistent with the Generalized Extreme Value Distribution*

Description

The distribution parameter object returned by functions of this package such as by `pargev` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfgev`, `quagev`, and `lmomgev` require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively. These functions internally use the `are.pargev.valid` function. The FORTRAN source code of Hosking provides the basis for the function.

Usage

```
are.pargev.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `pargev`.

Value

`TRUE`	If the parameters are `gev` consistent.
`FALSE`	If the parameters are not `gev` consistent.

Note

This function calls `is.gev` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`is.gev`

Examples

```
para <- pargev(lmom.ub(c(123,34,4,654,37,78)))
if(are.pargev.valid(para)) Q <- quagev(0.5,para)
```

`are.pargld.valid` *Are the Distribution Parameters Consistent with the Generalized Lambda Distribution*

Description

The distribution parameter object returned by functions of this package such as by `vec2par` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`quagld`) require consistent parameters to ensure that the Generalized Lambda Distribution is monotonic increasing on $0 \leq F \leq 1$, in which F is nonexceedance probability.

Usage

```
are.pargld.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `vec2par`.

Value

`TRUE`	If the parameters are `gld` consistent.
`FALSE`	If the parameters are not `gld` consistent.

Note

This function calls `is.gld` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Karian, Z.A., and Dudewicz, E.J., 2000, Fitting statistical distributions– The generalized lambda distribution and generalized bootstrap methods: CRC Press, Boca Raton, FL, 438 p.

See Also

is.gld

Examples

```
para <- vec2par(c(123,34,4,3),type='gld')
if(are.pargld.valid(para)) Q <- quagld(0.5,para)
```

---

are.parglo.valid — *Are the Distribution Parameters Consistent with the Generalized Logistic Distribution*

Description

The distribution parameter object returned by functions of this package such as by `parglo` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfglo`, `quaglo`, and `lmomglo` require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively. These functions internally use the `are.parglo.valid` function. The FORTRAN source code of Hosking provides the basis for the function.

Usage

```
are.parglo.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `parglo`.

Value

`TRUE`	If the parameters are `glo` consistent.
`FALSE`	If the parameters are not `glo` consistent.

Note

This function calls `is.glo` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

is.glo

Examples

```
para <- parglo(lmom.ub(c(123,34,4,654,37,78)))
if(are.parglo.valid(para)) Q <- quaglo(0.5,para)
```

---

are.pargno.valid — *Are the Distribution Parameters Consistent with the Generalized Normal Distribution*

Description

The distribution parameter object returned by functions of this package such as by `pargno` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfgno`, `quagno`, and `lmomgno` require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively. These functions internally use the `are.pargno.valid` function. The FORTRAN source code of Hosking provides the basis for the function.

Usage

```
are.pargno.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `pargno`.

Value

`TRUE`	If the parameters are `gno` consistent.
`FALSE`	If the parameters are not `gno` consistent.

Note

This function calls `is.gno` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`is.gno`

Examples

```
para <- pargno(lmom.ub(c(123,34,4,654,37,78)))
if(are.pargno.valid(para)) Q <- quagno(0.5,para)
```

`are.pargpa.valid` *Are the Distribution Parameters Consistent with the Generalized Pareto Distribution*

Description

The distribution parameter object returned by functions of this package such as by `pargpa` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfgpa`, `quagpa`, and `lmomgpa` require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively. These functions internally use the `are.pargpa.valid` function. The FORTRAN source code of Hosking provides the basis for the function.

Usage

```
are.pargpa.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `pargpa`.

Value

`TRUE`	If the parameters are `gpa` consistent.
`FALSE`	If the parameters are not `gpa` consistent.

Note

This function calls `is.gpa` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`is.gpa`

Examples

```
para <- pargpa(lmom.ub(c(123,34,4,654,37,78)))
if(are.pargpa.valid(para)) Q <- quagpa(0.5,para)
```

`are.pargum.valid` *Are the Distribution Parameters Consistent with the Gumbel Distribution*

Description

The distribution parameter object returned by functions of this package such as by `pargum` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfgum`, `quagum`, and `lmomgum` require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively. These functions internally use the `are.pargum.valid` function. The FORTRAN source code of Hosking provides the basis for the function.

Usage

```
are.pargum.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `pargum`.

Value

`TRUE`	If the parameters are `gum` consistent.
`FALSE`	If the parameters are not `gum` consistent.

Note

This function calls `is.gum` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`is.gum`

Examples

```
para <- pargum(lmom.ub(c(123,34,4,654,37,78)))
if(are.pargum.valid(para)) Q <- quagum(0.5,para)
```

`are.parkap.valid` *Are the Distribution Parameters Consistent with the Kappa Distribution*

Description

The distribution parameter object returned by functions of this package such as by `parkap` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfkap`, `quakap`, and `lmomkap` require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively. These functions internally use the `are.parkap.valid` function. The FORTRAN source code of Hosking provides the basis for the function.

Usage

```
are.parkap.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `parkap`.

Value

`TRUE`	If the parameters are `kap` consistent.
`FALSE`	If the parameters are not `kap` consistent.

Note

This function calls `is.kap` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

is.kap

Examples

```
para <- parkap(lmom.ub(c(123,34,4,654,37,78)))
if(are.parkap.valid(para)) Q <- quakap(0.5,para)
```

---

are.parnor.valid — *Are the Distribution Parameters Consistent with the Normal Distribution*

Description

The distribution parameter object returned by functions of this package such as by `parnor` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfnor`, `quanor`, and `lmomnor` require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively. These functions internally use the `are.parnor.valid` function. The FORTRAN source code of Hosking provides the basis for the function.

Usage

```
are.parnor.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `parnor`.

Value

`TRUE`	If the parameters are `nor` consistent.
`FALSE`	If the parameters are not `nor` consistent.

Note

This function calls `is.nor` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`is.nor`

Examples

```
para <- parnor(lmom.ub(c(123,34,4,654,37,78)))
if(are.parnor.valid(para)) Q <- quanor(0.5,para)
```

`are.parpe3.valid` *Are the Distribution Parameters Consistent with the Pearson Type III Distribution*

Description

The distribution parameter object returned by functions of this package such as by `parpe3` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfpe3`, `quape3`, and `lmompe3` require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively. These functions internally use the `are.parpe3.valid` function. The FORTRAN source code of Hosking provides the basis for the function.

Usage

```
are.parpe3.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `parpe3`.

Value

`TRUE`	If the parameters are `pe3` consistent.
`FALSE`	If the parameters are not `pe3` consistent.

Note

This function calls `is.pe3` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`is.pe3`

Examples

```
para <- parpe3(lmom.ub(c(123,34,4,654,37,78)))
if(are.parpe3.valid(para)) Q <- quape3(0.5,para)
```

---

are.par.valid — *Are the Distribution Parameters Consistent with the Distribution*

Description

This function is a dispatcher on top of the `are.parCCC.valid` functions, where `CCC` represents the distribution type: `exp`, `gam`, `gev`, `glo`, `gno`, `gpa`, `gum`, `kap`, `nor`, `pe3`, or `wak`. Internally, this function is called only by `vec2par` in the process of converting a vector into a proper distribution parameter object for this package.

Usage

```
are.par.valid(para)
```

Arguments

`para`	A distribution parameter object having at least attributes `type` and `para`.

Value

`TRUE`	If the parameters are consistent with the distribution specified by the type attribute.
`FALSE`	If the parameters are not consistent with the distribution specified by the type attribute.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

vec2par

Examples

```
vec  <- c(12,120)           # parameters of exponential distribution
para <- vec2par(vec,'exp')  # build exponential distribution parameter object
# The following two conditionals are equivalent as are.parexp.valid() is called
# within are.par.valid().
if(are.par.valid(para))    Q <- quaexp(0.5,para)
if(are.parexp.valid(para)) Q <- quaexp(0.5,para)
```

---

are.parwak.valid *Are the Distribution Parameters Consistent with the Wakeby Distribution*

Description

The distribution parameter object returned by functions of this package such as by `parwak` are consistent with the corresponding distribution, otherwise a list would not have been returned. However, other functions (`cdfwak`, `quawak`, and `lmomwak` require consistent parameters to return the cumulative probability (nonexceedance), quantile, and L-moments of the distribution, respectively. These functions internally use the `are.parwak.valid` function. The FORTRAN source code of Hosking provides the basis for the function.

Usage

```
are.parwak.valid(para)
```

Arguments

`para`	A distribution parameter list returned by `parwak`.

Value

`TRUE`	If the parameters are `wak` consistent.
`FALSE`	If the parameters are not `wak` consistent.

Note

This function calls `is.wak` to verify consistency between the distribution parameter object and the intent of the user.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`is.wak`

Examples

```
para <- parwak(lmom.ub(c(123,34,4,654,37,78)))
if(are.parwak.valid(para)) Q <- quawak(0.5,para)
```

---

cdfcau — *Cumulative Distribution Function of the Cauchy Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Cauchy distribution given parameters (ξ and α) of the distribution provided by `vec2par`. The cumulative distribution function of the distribution is

$$F(x) = \frac{atan(\frac{x-\xi}{\alpha})}{\pi} + 0.5$$

where $F(x)$ is the nonexceedance probability for quantile x, ξ is a location parameter and α is a scale parameter.

Usage

```
cdfcau(x, para)
```

Arguments

`x`	A real value.
`para`	The parameters from `vec2par` or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Gilchirst, W.G., 2000, Statistical modeling with quantile functions: Chapman and Hall/CRC, Boca Raton, FL.

See Also

`quacau`, `vec2par`

Examples

```
para <- c(12,12)
cdfcau(50,vec2par(para,type='cau'))
```

---

cdfexp — *Cumulative Distribution Function of the Exponential Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Exponential distribution given parameters (ξ and α) of the distribution computed by `parexp`. The cumulative distribution function of the distribution is

$$F(x) = 1 - e^{\left(\frac{-(x-\xi)}{\alpha}\right)}$$

where $F(x)$ is the nonexceedance probability for the quantile x, ξ is a location parameter and α is a scale parameter.

Usage

```
cdfexp(x, para)
```

Arguments

`x`	A real value.
`para`	The parameters from `parexp` or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`quaexp`, `parexp`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
cdfexp(50,parexp(lmr))
```

`cdfgam` *Cumulative Distribution Function of the Gamma Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Gamma distribution given parameters (α and β) of the distribution computed by `pargam`. The cumulative distribution function of the distribution has no explicit form, where α is a shape parameter and β is a scale parameter in the R syntax.

Usage

```
cdfgam(x, para)
```

Arguments

`x`	A real value.
`para`	The parameters from `pargam` or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`quagam`, `pargam`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
cdfgam(50,pargam(lmr))
```

`cdfgev` *Cumulative Distribution Function of the Generalized Extreme Value Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Generalized Extreme Value distribution given parameters (ξ, α, and κ) of the distribution computed by `pargev`. The cumulative distribution function of the distribution is

$$F(x) = e^{-e^{-y}}$$

$$y = -\kappa^{-1} \log\left(1 - \frac{\kappa(x - \xi)}{\alpha}\right)$$

for $\kappa \neq 0$

$$y = (x - \xi)/\alpha$$

for $\kappa = 0$

where $F(x)$ is the nonexceedance probability for quantile x, ξ is a location parameter, α is a scale parameter, and κ is a shape parameter.

Usage

```
cdfgev(x, para)
```

Arguments

`x`	A real value.
`para`	The parameters from `pargev` or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

quagev, pargev

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
cdfgev(50,pargev(lmr))
```

`cdfglo` *Cumulative Distribution Function of the Generalized Logistic Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Generalized Logistic distribution given parameters (ξ, α, and κ) of the distribution computed by parglo. The cumulative distribution function of the distribution is

$$F(x) = 1/(1 + e^{-y})$$

where y is

$$y = -\kappa^{-1} \log\left(1 - \frac{\kappa(x - \xi)}{\alpha}\right)$$

for $\kappa \neq 0$

$$y = (x - \xi)/\alpha$$

for $\kappa = 0$

where $F(x)$ is the nonexceedance probability for quantile x, ξ is a location parameter, α is a scale parameter, and κ is a shape parameter.

Usage

```
cdfglo(x, para)
```

Arguments

`x`	A real value.
`para`	The parameters from parglo or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

quaglo, parglo

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
cdfglo(50,parglo(lmr))
```

---

cdfgno — *Cumulative Distribution Function of the Generalized Normal Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Generalized Normal distribution given parameters (ξ, α, and κ) of the distribution computed by pargno. The cumulative distribution function of the distribution is

$$F(x) = \Phi(y)$$

where Φ is the cumulative ditribution function of the standard normal distribution and y is

$$y = -\kappa^{-1} \log \left(1 - \frac{\kappa(x - \xi)}{\alpha}\right)$$

for $\kappa \neq 0$

$$y = (x - \xi)/\alpha$$

for $\kappa = 0$

where $F(x)$ is the nonexceedance probability for quantile x, ξ is a location parameter, α is a scale parameter, and κ is a shape parameter.

Usage

```
cdfgno(x, para)
```

Arguments

x	A real value.
para	The parameters from pargno or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

quagno, pargno

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
cdfgno(50,pargno(lmr))
```

---

cdfgpa — *Cumulative Distribution Function of the Generalized Pareto Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Generalized Pareto distribution given parameters (ξ, α, and κ) of the distribution computed by pargpa. The cumulative distribution function of the distribution is

$$F(x) = 1 - e^{-y}$$

where y is

$$y = -\kappa^{-1} \log \left(1 - \frac{\kappa(x - \xi)}{\alpha}\right)$$

for $\kappa \neq 0$

$$y = (x - \xi)/A$$

for $\kappa = 0$

where $F(x)$ is the nonexceedance probability for quantile x, ξ is a location parameter, α is a scale parameter, and κ is a shape parameter.

Usage

```
cdfgpa(x, para)
```

Arguments

x	A real value.
para	The parameters from pargpa or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

quagpa, pargpa

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
cdfgpa(50,pargpa(lmr))
```

---

cdfgum *Cumulative Distribution Function of the Gumbel Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Gumbel distribution given parameters (ξ and α) of the distribution computed by pargum. The cumulative distribution function of the distribution is

$$F(x) = e^{-e^{\left(-\frac{(x-\xi)}{\alpha}\right)}}$$

where $F(x)$ is the nonexceedance probability for quantile x, ξ is a location parameter, and α is a scale parameter.

Usage

```
cdfgum(x, para)
```

Arguments

`x`	A real value.
`para`	The parameters from `pargum` or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`quagum`, `pargum`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
cdfgum(50,pargum(lmr))
```

`cdfkap` *Cumulative Distribution Function of the Kappa Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Kappa distribution given parameters (ξ, α, and κ, h) of the distribution computed by `parkap`. The cumulative distribution function of the distribution is

$$F(x) = \left(1 - h\left(1 - \frac{\kappa(x-\xi)}{\alpha}\right)^{1/\kappa}\right)^{1/h}$$

where $F(x)$ is the nonexceedance probability for quantile x, ξ is a location parameter, α is a scale parameter, κ is a shape parameter, and h is another shape parameter.

Usage

```
cdfkap(x, para)
```

Arguments

`x`	A real value.
`para`	The parameters from `parkap` or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`quakap`, `parkap`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78,21,32,231,23))
cdfkap(50,parkap(lmr))
```

`cdfnor` *Cumulative Distribution Function of the Normal Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Normal distribution given parameters of the distribution computed by `parnor`. The cumulative distribution function of the distribution is

$$F(x) = \Phi(x - \mu/\sigma)$$

where $F(x)$ is the nonexceedance probability for quantile x, μ is the arithmetic mean, and σ is the standard deviation, and Φ is the cumulative distribution function of the standard normal distribution.

Usage

```
cdfnor(x, para)
```

Arguments

`x`	A real value.
`para`	The parameters from `parnor` or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`quanor`, `parnor`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
cdfnor(50,parnor(lmr))
```

`cdfpe3` *Cumulative Distribution Function of the Pearson Type III Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Pearson Type III distribution given parameters (ξ, α, and γ) of the distribution computed by `parpe3`. The cumulative distribution function of the distribution is

$$F(x) = \frac{G\left(\alpha, \frac{x-\xi}{\gamma}\right)}{\Gamma(\alpha)}$$

where $F(x)$ is the nonexceedance probability for quantile x, G is the incomplete gamma function, Γ is the gamma function, ξ is a location parameter, α is a scale parameter, and γ is a shape parameter.

Usage

```
cdfpe3(x, para)
```

Arguments

`x`	A real value.
`para`	The parameters from `parpe3` or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`quape3`, `parpe3`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
cdfpe3(50,parpe3(lmr))
```

---

cdfwak — *Cumulative Distribution Function of the Wakeby Distribution*

Description

This function computes the cumulative probability or nonexceedance probability of the Wakeby distribution given parameters (ξ, α, β, γ, and δ) of the distribution computed by `parwak`. The cumulative distribution function of the distribution has no explicit form.

Usage

```
cdfwak(x, wakpara)
```

Arguments

`x`	A real value.
`wakpara`	The parameters from `parwak` or similar.

Value

Nonexceedance probability (F) for x.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`quawak`, `parwak`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
cdfwak(50,parwak(lmr))
```

`freq.curve.all` *Compute Frequency Curve for All Distributions*

Description

This function is dispatcher on top of the suite of `freq.curve.CCC` functions that compute frequency curves for the L-moments. Frequency curves in hydrologic science is a term typically renaming the more conventional quantile function. The notation `CCC` represents the three character notation for the distribution: `exp`, `gam`, `gev`, `glo`, `gno`, `gpa`, `gum`, `kap`, `nor`, `pe3`, and `wak`.

Usage

```
freq.curve.all(lmom)
```

Arguments

`lmom`	A L-moment object from `lmom.ub` or similar.

Value

An extensive R `list` of frequency curves.

Author(s)

W.H. Asquith

See Also

`freq.curve.exp`, `freq.curve.gam`, `freq.curve.gev`, `freq.curve.glo`, `freq.curve.gno`, `freq.curve.gpa`, `freq.curve.gum`, `freq.curve.kap`, `freq.curve.nor`, `freq.curve.pe3`, and `freq.curve.wak`

freq.curve.cau — *Frequency Curve of the Cauchy Distribution*

Description

This function returns the quantiles of the Cauchy distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.cau(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `vec2par`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Gilchirst, W.G., 2000, Statistical modeling with quantile functions: Chapman and Hall/CRC, Boca Raton, FL.

See Also

`quacau`, `nonexceeds`

Examples

```
fs <- nonexceeds()
para <- vec2par(c(12,12),type='cau')
plot(fs,freq.curve.cau(fs,para))
```

freq.curve.exp — *Frequency Curve of the Exponential Distribution*

Description

This function returns the quantiles of the Exponential distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.exp(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `parexp`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`parexp`, `quaexp`, `nonexceeds`

Examples

```
fs <- nonexceeds()
lmr <- lmom.ub(c(123,34,4,654,37,78))
para <- parexp(lmr)
plot(fs,freq.curve.exp(fs,para))
```

freq.curve.gam *Frequency Curve of the Gamma Distribution*

Description

This function returns the quantiles of the Gamma distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.gam(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `pargam`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`pargam`, `quagam`, `nonexceeds`

Examples

```
fs <- nonexceeds()
lmr <- lmom.ub(c(123,34,4,654,37,78))
para <- pargam(lmr)
plot(fs,freq.curve.gam(fs,para))
```

`freq.curve.gev` *Frequency Curve of the Generalized Extreme Value Distribution*

Description

This function returns the quantiles of the Generalized Extreme Value distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.gev(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `pargev`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`pargev`, `quagev`, `nonexceeds`

Examples

```
fs <- nonexceeds()
lmr <- lmom.ub(c(123,34,4,654,37,78))
para <- pargev(lmr)
plot(fs,freq.curve.gev(fs,para))
```

freq.curve.gld — *Frequency Curve of the Generalized Lambda Distribution*

Description

This function returns the quantiles of the Generalized Lambda distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.gld(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `vec2par`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Karian, Z.A., and Dudewicz, E.J., 2000, Fitting statistical distributions– The generalized lambda distribution and generalized bootstrap methods: CRC Press, Boca Raton, FL, 438 p.

See Also

`quagld`, `nonexceeds`

Examples

```
fs <- nonexceeds()
para <- vec2par(c(123,34,4,3),type="gld")
plot(fs,freq.curve.gld(fs,para))
```

freq.curve.glo — *Frequency Curve of the Generalized Logistic Distribution*

Description

This function returns the quantiles of the Generalized Logistic distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.glo(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `parglo`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`parglo`, `quaglo`, `nonexceeds`

Examples

```
fs <- nonexceeds()
lmr <- lmom.ub(c(123,34,4,654,37,78))
para <- parglo(lmr)
plot(fs,freq.curve.glo(fs,para))
```

`freq.curve.gno` *Frequency Curve of the Generalized Normal Distribution*

Description

This function returns the quantiles of the Generalized Normal (log-Normal) distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.gno(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `pargno`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`pargno`, `quagno`, `nonexceeds`

Examples

```
fs <- nonexceeds()
lmr <- lmom.ub(c(123,34,4,654,37,78))
para <- pargno(lmr)
plot(fs,freq.curve.gno(fs,para))
```

freq.curve.gpa *Frequency Curve of the Generalized Pareto Distribution*

Description

This function returns the quantiles of the Generalized Pareto distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.gpa(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `pargpa`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`pargpa`, `quagpa`, `nonexceeds`

Examples

```
fs <- nonexceeds()
lmr <- lmom.ub(c(123,34,4,654,37,78))
para <- pargpa(lmr)
plot(fs,freq.curve.gpa(fs,para))
```

freq.curve.gum — *Frequency Curve of the Gumbel Distribution*

Description

This function returns the quantiles of the Gumbel distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.gum(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `pargum`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`pargum`, `quagum`, `nonexceeds`

Examples

```
fs <- nonexceeds()
lmr <- lmom.ub(c(123,34,4,654,37,78))
para <- pargum(lmr)
plot(fs,freq.curve.gum(fs,para))
```

`freq.curve.kap` *Frequency Curve of the Kappa Distribution*

Description

This function returns the quantiles of the Kappa distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.kap(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `parkap`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`parkap`, `quakap`, `nonexceeds`

Examples

```
fs <- nonexceeds()
lmr <- lmom.ub(c(13,34,4,65,37,78,60,450,23,13,340))
para <- parkap(lmr)
plot(fs,freq.curve.kap(fs,para))
```

freq.curve.nor — *Frequency Curve of the Normal Distribution*

Description

This function returns the quantiles of the Normal distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.nor(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `parnor`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`parnor`, `quanor`, `nonexceeds`

Examples

```
fs <- nonexceeds()
lmr <- lmom.ub(c(123,34,4,654,37,78))
para <- parnor(lmr)
plot(fs,freq.curve.nor(fs,para))
```

freq.curve.pe3 *Frequency Curve of the Pearson Type III Distribution*

Description

This function returns the quantiles of the Pearson Type III distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.pe3(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `parpe3`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`parpe3`, `quape3`, `nonexceeds`

Examples

```
fs <- nonexceeds()
lmr <- lmom.ub(c(123,34,4,654,37,78))
para <- parpe3(lmr)
plot(fs,freq.curve.pe3(fs,para))
```

`freq.curve.wak` *Frequency Curve of the Wakeby Distribution*

Description

This function returns the quantiles of the Wakeby distribution given a vector of nonexceedance probabilities and the parameters of the distribution. Because in magnitude and frequency analysis the frequency curve is typically the objective, this is a convenient function to increase analysis efficiency.

Usage

```
freq.curve.wak(fs, para)
```

Arguments

`fs`	Vector of nonexceedance probabilities.
`para`	Parameters of the distribution as from `parwak`.

Value

A vector of quantiles for the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`parwak`, `quawak`, `nonexceeds`

Examples

```
fs <- nonexceeds()
lmr <- lmom.ub(c(123,34,4,654,37,78))
para <- parwak(lmr)
plot(fs,freq.curve.wak(fs,para))
```

INT.check.fs *INTernal Function to Check Vector of Nonexceedance Probabilities*

Description

This function checks that a nonexceedance probability (F) is in the $0 \leq F \leq 1$ range. It does not check that the distribution whether the function as specified by current parameters if valid for $F = 0$ or $F = 1$. End point checking is left to additional internal checks within the functions implementing the distribution. The function is intended for internal use within this library to build logic flow throughout the distribution functions. Users are not expected to need this function themselves. The `INT.check.fs` function is separate because of the heavy use of the logic across a myriad of functions in this package.

Usage

```
INT.check.fs(fs)
```

Arguments

`fs` A vector of nonexceedance probablity values.

Value

`TRUE` The nonexceedance probabilities are valid.

`FALSE` The nonexceedance probabilities are invalid.

Author(s)

W.H. Asquith

See Also

`freq.curve.exp`, `freq.curve.gam`, `freq.curve.gev`, `freq.curve.glo`, `freq.curve.gno`, `freq.curve.gpa`, `freq.curve.gum`, `freq.curve.kap`, `freq.curve.nor`, `freq.curve.pe3`, and `freq.curve.wak`

INT.kapicase1 *INTernal Function for Kappa Distribution–ICASE 1*

Description

This is an internal function supporting flags named ICASE in the Hosking FORTRAN algorithms related to the processing of the Kappa distribution. Users are not expected to have any need to use this function themselves.

Usage

```
INT.kapicase1(U, A, G, H)
```

Arguments

`U`	Location parameter of Kappa distribution.
`A`	Scale parameter of Kappa distribution.
`G`	Shape parameter of Kappa distribution.
`H`	Higher-shape parameter of Kappa distribution.

Value

The Probability-Weighted Moments of the Kappa distribution for the ICASE number.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

See Also

`lmomkap`

`INT.kapicase2` *INTernal Function for Kappa Distribution–ICASE 2*

Description

This is an internal function supporting flags named ICASE in the Hosking FORTRAN algorithms related to the processing of the Kappa distribution. Users are not expected to have any need to use this function themselves.

Usage

```
INT.kapicase2(U, A, G, H)
```

Arguments

`U`	Location parameter of Kappa distribution.
`A`	Scale parameter of Kappa distribution.
`G`	Shape parameter of Kappa distribution.
`H`	Higher-shape parameter of Kappa distribution.

Value

The Probability-Weighted Moments of the Kappa distribution for the ICASE number.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

See Also

lmomkap

INT.kapicase3 *INTernal Function for Kappa Distribution–ICASE 3*

Description

This is an internal function supporting flags named ICASE in the Hosking FORTRAN algorithms related to the processing of the Kappa distribution. Users are not expected to have any need to use this function themselves.

Usage

```
INT.kapicase3(U, A, G, H)
```

Arguments

U	Location parameter of Kappa distribution.
A	Scale parameter of Kappa distribution.
G	Shape parameter of Kappa distribution.
H	Higher-shape parameter of Kappa distribution.

Value

The Probability-Weighted Moments of the Kappa distribution for the ICASE number.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

See Also

lmomkap

INT.kapicase4 *INTernal Function for Kappa Distribution–ICASE 4*

Description

This is an internal function supporting flags named ICASE in the Hosking FORTRAN algorithms related to the processing of the Kappa distribution. Users are not expected to have any need to use this function themselves.

Usage

```
INT.kapicase4(U, A, G, H)
```

Arguments

U	Location parameter of Kappa distribution.
A	Scale parameter of Kappa distribution.
G	Shape parameter of Kappa distribution.
H	Higher-shape parameter of Kappa distribution.

Value

The Probability-Weighted Moments of the Kappa distribution for the ICASE number.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

See Also

lmomkap

INT.kapicase5 *INTernal Function for Kappa Distribution–ICASE 5*

Description

This is an internal function supporting flags named ICASE in the Hosking FORTRAN algorithms related to the processing of the Kappa distribution. Users are not expected to have any need to use this function themselves.

Usage

```
INT.kapicase5(U, A, G, H)
```

Arguments

`U`	Location parameter of Kappa distribution.
`A`	Scale parameter of Kappa distribution.
`G`	Shape parameter of Kappa distribution.
`H`	Higher-shape parameter of Kappa distribution.

Value

The Probability-Weighted Moments of the Kappa distribution for the ICASE number.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

See Also

`lmomkap`

`INT.kapicase6` *INTernal Function for Kappa Distribution–ICASE 6*

Description

This is an internal function supporting flags named ICASE in the Hosking FORTRAN algorithms related to the processing of the Kappa distribution. Users are not expected to have any need to use this function themselves.

Usage

```
INT.kapicase6(U, A, G, H)
```

Arguments

`U`	Location parameter of Kappa distribution.
`A`	Scale parameter of Kappa distribution.
`G`	Shape parameter of Kappa distribution.
`H`	Higher-shape parameter of Kappa distribution.

Value

The Probability-Weighted Moments of the Kappa distribution for the ICASE number.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

See Also

`lmomkap`

`is.cau` *Is a Distribution Parameter Object Typed as Cauchy*

Description

The distribution parameter object returned by functions of this module such as by `vec2par` are typed by an attribute `type`. This function checks that type is `cau` for the Cauchy distribution.

Usage

```
is.cau(para)
```

Arguments

`para`	A parameter `list` returned from `vec2par`.

Value

`TRUE`	If the `type` attribute is `cau`.
`FALSE`	If the `type` is not `cau`.

Author(s)

W.H. Asquith

See Also

`vec2par`

Examples

```
para <- vec2par(c(12,12),type='cau')
if(is.cau(para) == TRUE) {
  Q <- quacau(0.5,para)
}
```

`is.exp` *Is a Distribution Parameter Object Typed as Exponential*

Description

The distribution parameter object returned by functions of this module such as by `parexp` are typed by an attribute `type`. This function checks that type is `exp` for the Exponential distribution.

Usage

```
is.exp(para)
```

Arguments

`para`	A parameter `list` returned from `parexp`.

Value

`TRUE`	If the `type` attribute is `exp`.
`FALSE`	If the `type` is not `exp`.

Author(s)

W.H. Asquith

See Also

`parexp`

Examples

```
para <- parexp(lmom.ub(c(123,34,4,654,37,78)))
if(is.exp(para) == TRUE) {
  Q <- quaexp(0.5,para)
}
```

`is.gam` *Is a Distribution Parameter Object Typed as Gamma*

Description

The distribution parameter object returned by functions of this module such as by `pargam` are typed by an attribute `type`. This function checks that type is `gam` for the Gamma distribution.

Usage

```
is.gam(para)
```

Arguments

`para`	A parameter `list` returned from `pargam`.

Value

`TRUE`	If the `type` attribute is `gam`.
`FALSE`	If the `type` is not `gam`.

Author(s)

W.H. Asquith

See Also

`pargam`

Examples

```
para <- pargam(lmom.ub(c(123,34,4,654,37,78)))
if(is.gam(para) == TRUE) {
  Q <- quagam(0.5,para)
}
```

`is.gev` *Is a Distribution Parameter Object Typed as Generalized Extreme Value*

Description

The distribution parameter object returned by functions of this module such as by `pargev` are typed by an attribute `type`. This function checks that type is `gev` for the Generalized Extreme Value distribution.

Usage

```
is.gev(para)
```

Arguments

`para`	A parameter `list` returned from `pargev`.

Value

`TRUE`	If the `type` attribute is `gev`.
`FALSE`	If the `type` is not `gev`.

Author(s)

W.H. Asquith

See Also

`pargev`

Examples

```
para <- pargev(lmom.ub(c(123,34,4,654,37,78)))
if(is.gev(para) == TRUE) {
  Q <- quagev(0.5,para)
}
```

`is.gld` *Is a Distribution Parameter Object Typed as Generalized Lambda*

Description

The distribution parameter object returned by functions of this module such as by `vec2par` are typed by an attribute `type`. This function checks that type is `gld` for the Generalized Lambda distribution.

Usage

```
is.gld(para)
```

Arguments

`para`	A parameter `list` returned from `vec2par`.

Value

`TRUE`	If the `type` attribute is `gld`.
`FALSE`	If the `type` is not `gld`.

Author(s)

W.H. Asquith

See Also

`quagld`

Examples

```
para <- vec2par(c(123,120,3,2),type="gld")
if(is.gld(para) == TRUE) {
  Q <- quagld(0.5,para)
}
```

is.glo — *Is a Distribution Parameter Object Typed as Generalized Logistic*

Description

The distribution parameter object returned by functions of this module such as by `parglo` are typed by an attribute `type`. This function checks that type is `glo` for the Generalized Logistic distribution.

Usage

```
is.glo(para)
```

Arguments

`para`	A parameter `list` returned from `parglo`.

Value

`TRUE`	If the `type` attribute is `glo`.
`FALSE`	If the `type` is not `glo`.

Author(s)

W.H. Asquith

See Also

`parglo`

Examples

```
para <- parglo(lmom.ub(c(123,34,4,654,37,78)))
if(is.glo(para) == TRUE) {
  Q <- quaglo(0.5,para)
}
```

is.gno — *Is a Distribution Parameter Object Typed as Generalized Normal*

Description

The distribution parameter object returned by functions of this module such as by `pargno` are typed by an attribute `type`. This function checks that type is `gno` for the Generalized Normal distribution.

Usage

```
is.gno(para)
```

Arguments

`para`	A parameter `list` returned from `pargno`.

Value

`TRUE`	If the `type` attribute is `gno`.
`FALSE`	If the `type` is not `gno`.

Author(s)

W.H. Asquith

See Also

`pargno`

Examples

```
para <- pargno(lmom.ub(c(123,34,4,654,37,78)))
if(is.gno(para) == TRUE) {
  Q <- quagno(0.5,para)
}
```

`is.gpa` *Is a Distribution Parameter Object Typed as Generalized Pareto*

Description

The distribution parameter object returned by functions of this module such as by `pargpa` are typed by an attribute `type`. This function checks that type is `gpa` for the Generalized Pareto distribution.

Usage

```
is.gpa(para)
```

Arguments

`para`	A parameter `list` returned from `pargpa`.

Value

`TRUE`	If the `type` attribute is `gpa`.
`FALSE`	If the `type` is not `gpa`.

Author(s)

W.H. Asquith

See Also

`pargpa`

Examples

```
para <- pargpa(lmom.ub(c(123,34,4,654,37,78)))
if(is.gpa(para) == TRUE) {
  Q <- quagpa(0.5,para)
}
```

is.gum *Is a Distribution Parameter Object Typed as Gumbel*

Description

The distribution parameter object returned by functions of this module such as by `pargum` are typed by an attribute `type`. This function checks that type is `gum` for the Gumbel distribution.

Usage

```
is.gum(para)
```

Arguments

`para`	A parameter `list` returned from `pargum`.

Value

`TRUE`	If the `type` attribute is `gum`.
`FALSE`	If the `type` is not `gum`.

Author(s)

W.H. Asquith

See Also

`pargum`

Examples

```
para <- pargum(lmom.ub(c(123,34,4,654,37,78)))
if(is.gum(para) == TRUE) {
  Q <- quagum(0.5,para)
}
```

`is.kap` *Is a Distribution Parameter Object Typed as Kappa*

Description

The distribution parameter object returned by functions of this module such as by `parkap` are typed by an attribute `type`. This function checks that type is `kap` for the Kappa distribution.

Usage

```
is.kap(para)
```

Arguments

`para`	A parameter `list` returned from `parkap`.

Value

`TRUE`	If the `type` attribute is `kap`.
`FALSE`	If the `type` is not `kap`.

Author(s)

W.H. Asquith

See Also

`parkap`

Examples

```
para <- parkap(lmom.ub(c(123,34,4,654,37,78)))
if(is.kap(para) == TRUE) {
  Q <- quakap(0.5,para)
}
```

`is.nor` *Is a Distribution Parameter Object Typed as Normal*

Description

The distribution parameter object returned by functions of this module such as by `parnor` are typed by an attribute `type`. This function checks that type is `nor` for the Normal distribution.

Usage

```
is.nor(para)
```

Arguments

`para`	A parameter `list` returned from `parnor`.

Value

`TRUE`	If the `type` attribute is `nor`.
`FALSE`	If the `type` is not `nor`.

Author(s)

W.H. Asquith

See Also

`parnor`

Examples

```
para <- parnor(lmom.ub(c(123,34,4,654,37,78)))
if(is.nor(para) == TRUE) {
  Q <- quanor(0.5,para)
}
```

---

is.pe3 *Is a Distribution Parameter Object Typed as Pearson Type III*

Description

The distribution parameter object returned by functions of this module such as by `parpe3` are typed by an attribute `type`. This function checks that type is `pe3` for the Pearson Type III distribution.

Usage

```
is.pe3(para)
```

Arguments

`para`	A parameter `list` returned from `parpe3`.

Value

`TRUE`	If the `type` attribute is `pe3`.
`FALSE`	If the `type` is not `pe3`.

Author(s)

W.H. Asquith

See Also

`parpe3`

Examples

```
para <- parpe3(lmom.ub(c(123,34,4,654,37,78)))
if(is.pe3(para) == TRUE) {
  Q <- quape3(0.5,para)
}
```

`is.wak` *Is a Distribution Parameter Object Typed as Wakeby*

Description

The distribution parameter object returned by functions of this module such as by `parwak` are typed by an attribute `type`. This function checks that type is `wak` for the Wakeby distribution.

Usage

```
is.wak(para)
```

Arguments

`para`	A parameter `list` returned from `parwak`.

Value

`TRUE`	If the `type` attribute is `wak`.
`FALSE`	If the `type` is not `wak`.

Author(s)

W.H. Asquith

See Also

`parwak`

Examples

```
para <- parwak(lmom.ub(c(123,34,4,654,37,78)))
if(is.wak(para) == TRUE) {
  Q <- quawak(0.5,para)
}
```

`Lcomoment.coefficients` *L-comoment Coefficient Matrix*

Description

Compute the L-comoment coefficients from an L-comoment matrix of order $k \geq 2$ and the $k = 2$ (2nd order) L-comoment matrix. This function requires that each matrix is already computed by the function `Lcomoment.matrix`.

Usage

```
Lcomoment.coefficients(Lk,L2)
```

Arguments

`Lk`	A $k \geq 2$ L-comoment matrix from `Lcomoment.matrix`.
`L2`	A $k = 2$ L-comoment matrix from `Lcomoment.matrix(Dataframe,k=2)`.

Details

L-correlation is computed by `Lcomoment.coefficients(L2,L2)` where `L2` is a $k = 2$ L-comoment matrix. L-coskew, L-cokurtosis, and so on are computed by `Lcomoment.coefficients(L3,L2)`, `Lcomoment.coefficients(L4,L2)`, and so on. The usual univariate L-moments as seen from `lmom.ub` are along the diagonal. This function does not make use of `lmom.ub`. The L-correlation is computed by extraction of the diagonal and dividing each row in the matrix by the corresponding value from the diagonal.

Value

An R `list` is returned.

`type`	The type of L-comoment representation in the matrix: "Lcomoment.coefficients".
`order`	The order of the matrix–extracted from the first matrix in arguments.
`matrix`	A $k \geq 2$ L-comoment coefficient matrix.

Note

The function begins with a capital letter. This is intentionally done so that lower case namespace is preserved. L-comoments are new in the literature and experimental in this package. By using a capital letter now, then `lcomoment.coefficients` remains an available name in future releases.

Author(s)

W.H. Asquith

Source

Serfling and Xiao (2006).

References

Serfling, R., and Xiao, P., 2006, Multivariate L-moments, preprint.

See Also

`lmom.ub`, `Lcomoment.matrix`, `Lcomoment.coefficients`

Examples

```
D      <- data.frame(X1=rnorm(30),X2=rnorm(30),X3=rnorm(30))
L2     <- Lcomoment.matrix(D,k=2)
L3     <- Lcomoment.matrix(D,k=3)
LkTAU3 <- Lcomoment.coefficients(L3,L2)
```

`Lcomoment.correlation` *L-correlation Matrix (L-correlation throught sample L-comoments)*

Description

Compute the L-correlation from an L-comoment matrix of order $k = 2$. This function assumes that each matrix is already computed by the function `Lcomoment.matrix`.

Usage

```
Lcomoment.correlation(L2)
```

Arguments

`L2`	A $k = 2$ L-comoment matrix from `Lcomoment.matrix(Dataframe,k=2)`.

Details

L-correlation is computed by `Lcomoment.coefficients(L2,L2)` where L2 is second order L-comoment matrix. The usual L-scale values as seen from `lmom.ub` are along the diagonal. This function does not make use of `lmom.ub` and can be used to verify computation of τ (coefficient of L-variation).

Value

An R `list` is returned.

`type`	The type of L-comoment representation in the matrix: "Lcomoment.coefficients"".
`order`	The order of the matrix–extracted from the first matrix in arguments.
`matrix`	A $k \geq 2$ L-comoment coefficient matrix.

Note

The function begins with a capital letter. This is intentionally done so that lower case namespace is preserved. L-comoments are new in the literature and experimental in this package. By using a capital letter now, then `lcomoment.correlation` remains an available name in future releases.

Author(s)

W.H. Asquith

Source

Serfling and Xiao (2006).

References

Serfling, R., and Xiao, P., 2006, Multivariate L-moments, preprint.

See Also

`lmom.ub`, `Lcomoment.matrix`, `Lcomoment.correlation`

Examples

```
D   <- data.frame(X1=rnorm(30),X2=rnorm(30),X3=rnorm(30))
L2  <- Lcomoment.matrix(D,k=2)
RHO <- Lcomoment.correlation(L2)
```

`Lcomoment.Lk12` *Compute a Single Sample L-comoment*

Description

Compute the L-comoment ($\lambda_{k[r:n]}$) for a given pair of random variables. The order of the L-comoments is specified.

Usage

```
Lcomoment.Lk12(X1,X2,k=1)
```

Arguments

`X1`	An array of random variables.
`X2`	Another array of random variables.
`k`	The order of the L-comoment to compute. The default is 1.

Details

L-comoments are computed from the concomitants of X2. That is, X2 is sorted in ascending order to create the order statistics of X2. X1 is in turn reshuffled to the order of X2 for form the concomitants of X2 (denoted as $X^{(12)}$). The concomitants are inturn used in a weighted summation and expectation calculation to compute the L-comoment of X1 to X2. The inverse can also be done (`Lcomoment.Lk12(X2,X1,k=1)`) and is not necessarily equal to (`Lcomoment.Lk12(X1,X2,k=1)`). The notation of Lk12 is to read “Lambda for kth order L-comoment”, where the 12 portion of the notation reflects that of Serfling and Xiao (2006). The weights for the computation are derived from calls by `Lcomoment.Lk12` to `Lcomoment.Wk`.

$$\hat{\lambda}_{k[12]} = n^{-1} \sum_{r=1}^{n} w^{(k)}_{r:n} X^{(12)}_{[r:n]}$$

The concomitants of X1 ($X^{(21)}$) are formed by sorted X1 in ascending order and in turn shuffling X2 by the order of X1. By symmetry the L-comoment is

$$\hat{\lambda}_{k[21]} = n^{-1} \sum_{r=1}^{n} w^{(k)}_{r:n} X^{(21)}_{[r:n]}$$

Value

A single L-comoment.

Note

The function begins with a capital letter. This is intentionally done so that lower case namespace is preserved. L-comoments are new in the literature and experimental in this package. By using a capital letter now, then `lcomoment.Lk12` remains an available name in future releases.

Author(s)

W.H. Asquith

Source

Serfling and Xiao (2006).

References

Serfling, R., and Xiao, P., 2006, Multivariate L-moments, preprint.

See Also

`Lcomoment.matrix`, `Lcomoment.Wk`

Examples

```
X1   <- rnorm(20)
X2   <- rnorm(20)
Lk12 <- Lcomoment.Lk12(X1,X2,k=1)
```

`Lcomoment.matrix` *Compute Sample L-comoment Matrix*

Description

Compute the L-comoments from a rectangular `data.frame` contain arrays of random variables. The order of the L-comoments is specified.

Usage

```
Lcomoment.matrix(DATAFRAME,k=1)
```

Arguments

`DATAFRAME`	A convential `data.frame` that is rectangular
`k`	The order of the L-comoments to compute. Default is $k = 1$

Details

L-comoments are computed for each item in the `data.frame`. L-comoments of order $k = 1$ are means and comeans. L-coments of order $k = 2$ are L-scale and L-coscale values. L-comoments of order $k = 3$ are L-skew and L-coskews. L-comoments of order $k = 4$ are L-kurtosis and L-cokurtosis, and so on. The usual univariate L-moments of order k as seen from `lmom.ub` are along the diagonal. This function does not make use of `lmom.ub`. The `Lcomoment.matrix` function calls `Lcomment.Lk12` for each cell in the matrix. The L-comoment matrix for d-random variables is

$$\mathbf{\Lambda}_{\boldsymbol{k}} = (\lambda_{k[ij]})$$

computed over the pairs $(X^{(i)}, X^{(j)})$, $1 \leq i$, $1 \leq d$.

Value

An R `list` is returned.

`type`	The type of L-comoment representation in the matrix: “Lcomoments”.
`order`	The order of the matrix–specified by k in the argument list.
`matrix`	A kth order L-comoment matrix.

Note

The function begins with a capital letter. This is intentionally done so that lower case namespace is preserved. L-comoments are new in the literature and experimental in this package. By using a capital letter now, then `lcomoment.matrix` remains an available name in future releases.

Author(s)

W.H. Asquith

Source

Serfling and Xiao (2006).

References

Serfling, R., and Xiao, P., 2006, Multivariate L-moments, preprint.

See Also

`Lcomoment.Lk12`, `Lcomoment.coefficients`, `lmom.ub`

Examples

```
D  <- data.frame(X1=rnorm(30),X2=rnorm(30),X3=rnorm(30))
L1 <- Lcomoment.matrix(D,k=1)
L2 <- Lcomoment.matrix(D,k=2)
```

`Lcomoment.Wk` *Weighting Coefficient for Sample L-comoment*

Description

Compute the weight factors for computation of an L-comoment for order `k`, order statistic `r`, and sample size `n`.

Usage

```
Lcomoment.Wk(k,r,n)
```

Arguments

`k`	Order of L-comoment being computed by parent calls to `Lcomoment.Wk`.
`r`	Order statistic index involved.
`n`	Sample size.

Details

This function computes the weight factors needed to calculation L-comoments and is interfaced or used by `Lcomoment.Lk12`. This function is not necessarily for end users. The weight factor $w^{(k)}_{r:n}$ is the discrete Legendre polynomial. The weight factors are well illustrated in figure 2.6 of Hosking and Wallis (1997).

$$\left(\; k-1\backslash j \; \right)$$

$$w^{(k)}_{r:n} = \sum_{j=0}^{min\{r-1,k-1\}} (-1)^{k-1-j} \left(\; k-1\backslash j \; \right) \left(\; k-1+j\backslash j \; \right) \left(\; n-1\backslash j \; \right)^{-1} \left(\; r-1\backslash j \; \right)$$

Value

A single L-comoment weight factor.

Note

The function begins with a capital letter. This is intentionally done so that lower case namespace is preserved. L-comoments are new in the literature and experimental in this package. By using a capital letter now, then `lcomoment.Wk` remains an available name in future releases.

Author(s)

W.H. Asquith

Source

Serfling and Xiao (2006).

References

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

Serfling, R., and Xiao, P., 2006, Multivariate L-moments, preprint.

See Also

`Lcomoment.Wk`

Examples

```
Wk <- Lcomoment.Wk(2,3,5)
# To compute the weight factors for L-skew and L-coskew (k=3) computation
# for a sample of size 20.
Wk <- matrix(nrow=20,ncol=1)
for(r in seq(1,20)) Wk[r] <- Lcomoment.Wk(3,r,20)
# plot(seq(1,20),Wk)
```

---

lmom2par — *Convert L-moments to the the Parameters of a Distribution*

Description

This function converts the L-moments of the data to the parameters of a distribution. The type of distribution is specified in the argument list: `exp`, `gam`, `gev`, `glo`, `gno`, `gpa`, `gum`, `kap`, `nor`, `pe3`, or `wak`.

Usage

```
lmom2par(lmom, type)
```

Arguments

`lmom`	An L-moment object such as that returned by `lmom.ub` or `pwm2lmom`
`type`	Three character distribution type (for example, `type='gev'`).

Value

An R `list` is returned.

`type`	The type of distribution in three character format.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

lmom2par

Examples

```
lmr      <- lmom.ub(rnorm(20))
para     <- lmom2par(lmr,type='nor')
frompara <- par2lmom(para)
lmom.diff(frompara,lmr)
```

---

lmom2pwm *L-moments to Probability-Weighted Moments*

Description

Converts the L-moments to the Probability-Weighted Moments (PWMs) given the L-moments. The conversion is linear so procedures based on L-moments are identical to those based on PWMs. The relation between L-moments and PWMs is shown with pwm2lmom.

Usage

```
lmom2pwm(lmom)
```

Arguments

lmom	An L-moment object created by lmom.ub or similar.

Details

The Probability Weighted Moments (PWMs) are linear combinations of the L-moments and therefore contain the same statistical information of the data as the L-moments. However, the PWMs are harder to interpret as measures of probability distributions. The PWMs are included here for theoretical completeness and are not intended for use with the majority of the other functions implementing the various probability distributions.

Value

An R list is returned.

BETA0	The first PWM–equal to the arithmetic mean.
BETA1	The second PWM.
BETA2	The third PWM.
BETA3	The fourth PWM.
BETA4	The fifth PWM.

Author(s)

W.H. Asquith

References

Greenwood, J.A., Landwehr, J.M., Matalas, N.C., and Wallis, J.R., 1979, Probability weighted moments–Definition and relation to parameters of several distributions expressable in inverse form: Water Resources Research, vol. 15, p. 1,049-1,054.

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `pwm.ub`, `pwm2lmom`

Examples

```
pwm <- lmom2pwm(lmom.ub(c(123,34,4,654,37,78)))

lmom2pwm(lmom.ub(rnorm(100)))
```

---

lmom.diff — *Difference Between L-moments of the Distribution and the L-moments of the Data*

Description

This function computes the difference between the L-moments derived from a parameterized distribution and the L-moments as computed from the data. This function is useful to characterize the bias that develops between the theoretical L-moments of a distribution and the L-moments of the data. This function also is an important test on the algorithms that fit distributions to the L-moments. The difference is computed as the L-moment from the distribution minus the L-moment of the data.

Usage

```
lmom.diff(lmomparm, lmomdata)
```

Arguments

`lmomparm`	L-moments of a distribution such as from `par2lmom`
`lmomdata`	L-moments of the data such as from `lmom.ub`

Value

```
[1] "THE FIVE DIFFERENCES BETWEEN L-MOMENTS OF DISTRIBUTION AND DATA"

[1] "Mean   L2    TAU3    TAU4    TAU5"

[1] -5.529431e-18  0.000000e+00  0.000000e+00  3.243155e-02
```

where the five values are the differences between the theoretical L-moments of the fitted distribution and the sample L-moments of the data (theoretical minus sample) in the titled column.

Author(s)

W.H. Asquith

See Also

par2lmom, lmom2par

Examples

```
lmr <- lmom.ub(rnorm(40))
para <- lmom2par(lmr, type = 'glo')
lmom.diff(par2lmom(para),lmr)
```

---

lmomexp — *L-moments of the Exponential Distribution*

Description

This function estimates the L-moments of the Exponential distribution given the parameters (ξ and α) from parexp. The L-moments in terms of the parameters are

$$\lambda_1 = \xi + \alpha$$

$$\lambda_2 = \alpha/2$$

$$\tau_3 = 1/3$$

$$\tau_4 = 1/6$$

$$\tau_5 = 1/10$$

Usage

```
lmomexp(para)
```

Arguments

para	The parameters of the distribution.

Value

An R `list` is returned.

`L1`	Arithmetic mean.
`L2`	L-scale–analogous to standard deviation.
`LCV`	coefficient of L-variation–analogous to coe. of variation.
`TAU3`	The third L-moment ratio or L-skew–analogous to skew.
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
`TAU5`	The fifth L-moment ratio.
`L3`	The third L-moment.
`L4`	The fourth L-moment.
`L5`	The fifth L-moment.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`parexp`, `quaexp`, `cdfexp`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
lmr
lmomexp(parexp(lmr))
```

`lmomgam` *L-moments of the Gamma Distribution*

Description

This function estimates the L-moments of the Gamma distribution given the parameters (α and β) from `pargam`. The L-moments in terms of the parameters are complicated and solved numerically.

Usage

```
lmomgam(para)
```

Arguments

`para` The parameters of the distribution.

Value

An R `list` is returned.

- `L1` Arithmetic mean.
- `L2` L-scale–analogous to standard deviation.
- `LCV` coefficient of L-variation–analogous to coe. of variation.
- `TAU3` The third L-moment ratio or L-skew–analogous to skew.
- `TAU4` The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
- `TAU5` The fifth L-moment ratio.
- `L3` The third L-moment.
- `L4` The fourth L-moment.
- `L5` The fifth L-moment.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`pargam`, `quagam`, `cdfgam`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
lmr
lmomgam(pargam(lmr))
```

`lmomgev` *L-moments of the Generalized Extreme Value Distribution*

Description

This function estimates the L-moments of the Generalized Extreme Value distribution given the parameters (ξ, α, and κ) from `pargev`. The L-moments in terms of the parameters are

$$\lambda_1 = \xi + \frac{\alpha}{\kappa}(1 - \Gamma(1 + \kappa))$$

$$\lambda_2 = \frac{\alpha}{\kappa}(1 - 2^{-\kappa})\Gamma(1 + \kappa)$$

$$\tau_3 = \frac{2(1 - 3^{-\kappa})}{1 - 2^{-\kappa}} - 3$$

$$\tau_4 = \frac{5(1 - 4^{-\kappa}) - 10(1 - 3^{-\kappa}) + 6(1 - 2^{-\kappa})}{1 - 2^{-\kappa}}$$

Usage

```
lmomgev(para)
```

Arguments

`para`	The parameters of the distribution.

Value

An R `list` is returned.

`L1`	Arithmetic mean.
`L2`	L-scale–analogous to standard deviation.
`LCV`	coefficient of L-variation–analogous to coefficient of variation.
`TAU3`	The third L-moment ratio or L-skew–analogous to skew.
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
`TAU5`	The fifth L-moment ratio.
`L3`	The third L-moment.
`L4`	The fourth L-moment.
`L5`	The fifth L-moment.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

pargev, quagev, cdfgev

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
lmr
lmomgev(pargev(lmr))
```

---

lmomglo — *L-moments of the Generalized Logistic Distribution*

Description

This function estimates the L-moments of the Generalized Logistic distribution given the parameters (ξ, α, and κ) from parglo. The L-moments in terms of the parameters are

$$\lambda_1 = \xi + \alpha \left(\frac{1}{\kappa} - \frac{\pi}{\sin(\kappa\pi)} \right)$$

$$\lambda_2 = \frac{\alpha\kappa\pi}{\sin(\kappa\pi)}$$

$$\tau_3 = -\kappa$$

$$\tau_4 = \frac{(1 + 5\kappa^2)}{6}$$

Usage

```
lmomglo(para)
```

Arguments

`para`	The parameters of the distribution.

Value

An R `list` is returned.

`L1`	Arithmetic mean.
`L2`	L-scale–analogous to standard deviation.
`LCV`	coefficient of L-variation–analogous to coe. of variation.
`TAU3`	The third L-moment ratio or L-skew–analogous to skew.
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
`TAU5`	The fifth L-moment ratio.
`L3`	The third L-moment.
`L4`	The fourth L-moment.
`L5`	The fifth L-moment.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`parglo`, `quaglo`, `cdfglo`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
lmr
lmomglo(parglo(lmr))
```

`lmomgno` *L-moments of the Generalized Normal Distribution*

Description

This function estimates the L-moments of the Generalized Normal (log-Normal) distribution given the parameters (ξ, α, and κ) from `pargno`. The L-moments in terms of the parameters are

$$\lambda_1 = \xi + \frac{\alpha}{\kappa}(1 - e^{\kappa^2/2})$$

$$\lambda_2 = \frac{\alpha}{\kappa}(e^{\kappa^2/2})(1 - 2\Phi(-\kappa/\sqrt{2}))$$

where Φ is the cumulative distribution of the standard normal distribution. There are no simple expressions for τ_3, τ_4, and τ_5. Log transformation of the data prior to fitting of the Generalized Normal distribution is not required.

Usage

```
lmomgno(para)
```

Arguments

`para`	The parameters of the distribution.

Value

An R `list` is returned.

`L1`	Arithmetic mean.
`L2`	L-scale–analogous to standard deviation.
`LCV`	coefficient of L-variation–analogous to coe. of variation.
`TAU3`	The third L-moment ratio or L-skew–analogous to skew.
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
`TAU5`	The fifth L-moment ratio.
`L3`	The third L-moment.
`L4`	The fourth L-moment.
`L5`	The fifth L-moment.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`pargno`, `quagno`, `cdfgno`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
lmr
lmomgno(pargno(lmr))
```

`lmomgpa` *L-moments of the Generalized Pareto Distribution*

Description

This function estimates the L-moments of the Generalized Pareto distribution given the parameters (ξ, α, and κ) from `pargpa`. The L-moments in terms of the parameters are

$$\lambda_1 = \xi + \frac{\alpha}{1+\kappa}$$

$$\lambda_2 = \frac{\alpha}{(1+\kappa)(2+\kappa)}$$

$$\tau_3 = \frac{(1-\kappa)}{(3+\kappa)}$$

$$\tau_4 = \frac{(1-\kappa)(2-\kappa)}{(3+\kappa)(4+\kappa)}$$

Usage

```
lmomgpa(para)
```

Arguments

`para`	The parameters of the distribution.

Value

An R `list` is returned.

`L1`	Arithmetic mean.
`L2`	L-scale–analogous to standard deviation.
`LCV`	coefficient of L-variation–analogous to coe. of variation.
`TAU3`	The third L-moment ratio or L-skew–analogous to skew.
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
`TAU5`	The fifth L-moment ratio.
`L3`	The third L-moment.
`L4`	The fourth L-moment.
`L5`	The fifth L-moment.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

pargpa, quagpa, cdfgpa

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
lmr
lmomgpa(pargpa(lmr))
```

---

lmomgum — *L-moments of the Gumbel Distribution*

Description

This function estimates the L-moments of the Gumbel distribution given the parameters (ξ and α) from pargum. The L-moments in terms of the parameters are

$$\lambda_1 = \xi + (0.5722\ldots)\alpha$$

$$\lambda_2 = \alpha \log(2)$$

$$\tau_3 = 0.169925$$

$$\tau_4 = 0.150375$$

$$\tau_5 = 0.055868$$

Usage

```
lmomgum(para)
```

Arguments

para	The parameters of the distribution.

Value

An R `list` is returned.

`L1`	Arithmetic mean.
`L2`	L-scale–analogous to standard deviation.
`LCV`	coefficient of L-variation–analogous to coe. of variation.
`TAU3`	The third L-moment ratio or L-skew–analogous to skew.
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
`TAU5`	The fifth L-moment ratio.
`L3`	The third L-moment.
`L4`	The fourth L-moment.
`L5`	The fifth L-moment.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`pargum`, `quagum`, `cdfgum`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
lmr
lmomgum(pargum(lmr))
```

`lmomkap` *L-moments of the Kappa Distribution*

Description

This function estimates the L-moments of the Kappa distribution given the parameters (ξ, α, κ, and h) from `parkap`. The L-moments in terms of the parameters are complicated and are solved numerically.

Usage

```
lmomkap(para)
```

Arguments

`para`	The parameters of the distribution.

Value

An R `list` is returned.

`L1`	Arithmetic mean.
`L2`	L-scale–analogous to standard deviation.
`LCV`	coefficient of L-variation–analogous to coe. of variation.
`TAU3`	The third L-moment ratio or L-skew–analogous to skew.
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
`TAU5`	The fifth L-moment ratio.
`L3`	The third L-moment.
`L4`	The fourth L-moment.
`L5`	The fifth L-moment.

Author(s)

W.H. Asquith

References

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Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`parkap`, `quakap`, `cdfkap`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
lmr
lmomkap(parkap(lmr))
```

lmomnor	*L-moments of the Normal Distribution*

Description

This function estimates the L-moments of the Normal distribution given the parameters (μ and σ) from `parnor`. The L-moments in terms of the parameters are

$$\lambda_1 = \mu$$

$$\lambda_2 = \sqrt{\pi}\sigma$$

$$\tau_3 = 0$$

$$\tau_4 = 0.122602$$

$$\tau_5 = 0$$

Usage

```
lmomnor(para)
```

Arguments

`para`	The parameters of the distribution.

Value

An R `list` is returned.

`L1`	Arithmetic mean.
`L2`	L-scale–analogous to standard deviation.
`LCV`	coefficient of L-variation–analogous to coe. of variation.
`TAU3`	The third L-moment ratio or L-skew–analogous to skew.
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
`TAU5`	The fifth L-moment ratio.
`L3`	The third L-moment.
`L4`	The fourth L-moment.
`L5`	The fifth L-moment.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

parnor, quanor, cdfnor

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
lmr
lmomnor(parnor(lmr))
```

---

lmompe3 — *L-moments of the Pearson Type III Distribution*

Description

This function estimates the L-moments of the Pearson Type III distribution given the parameters (ξ, α, and γ) from parpe3. The L-moments in terms of the parameters are complicated and solved numerically.

Usage

```
lmompe3(para)
```

Arguments

para	The parameters of the distribution.

Value

An R `list` is returned.

L1	Arithmetic mean.
L2	L-scale–analogous to standard deviation.
LCV	coefficient of L-variation–analogous to coe. of variation.
TAU3	The third L-moment ratio or L-skew–analogous to skew.
TAU4	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
TAU5	The fifth L-moment ratio.
L3	The third L-moment.
L4	The fourth L-moment.
L5	The fifth L-moment.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

parpe3, quape3, cdfpe3

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
lmr
lmompe3(parpe3(lmr))
```

---

lmom.references *Important References Related to L-moments*

Description

A subtantial body of statistical research provides foundation for the theory of L-moments and demonstration of L-moment theory in practice exists. Whereas, in many ways, J.R.M. Hosking should be considered the father of L-moments, there are indeed many contributors to L-moment literature. Further, R. Serfling and P. Xiao in 2006 have taken up the reigns of multivariate L-moments. A substantial sampling is provided in the documentation of this package for the benefit of users.

Author(s)

W.H. Asquith

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`lmom.test.all` *Test All lmom.CCC.test Functions*

Description

This function is a dispatcher on top of `lmom.CCC.test` functions, where `CCC` represents distribution: `exp`, `gam`, `gev`, `glo`, `gno`, `gpa`, `gum`, `kap`, `nor`, `pe3`, and `wak`. The reason for this function is provide an example and builtin tool to assess the performance of the algorithms implements the L-moments for the supported univariate distributions functions. This function is to broadly call each supported distribution in the library through (1) computation of the L-moments of the data, (2) computation of the corresponding parameters of the distribution, and (3) return computation of the of the theoretical L-moments of the distribution. The differences between the sample and theoretical L-moments are produced by `lmom.diff`. Further the median quantile of the distribution is computed through the quantile function, and in turn, the median nonexceedance probability is computed through the cumulative distribution function.

Usage

```
lmom.test.all(data)
```

Arguments

`data`	A vector of data.

Value

This is a high level function and is not intended to return anything other than output to the user.

Author(s)

W.H. Asquith

See Also

`lmom.diff`, `lmom.test.exp`, `lmom.test.gam`, `lmom.test.gev`, `lmom.test.glo`, `lmom.test.gno`, `lmom.test.gpa`, `lmom.test.gum`, `lmom.test.kap`, `lmom.test.nor`, `lmom.test.pe3`, `lmom.test.wak`,

Examples

```
lmom.test.all(c(123,34,4,654,37,78))
```

`lmom.test.exp` *Test L-moment and Parameter Algorithms of the Exponential Distribution*

Description

This function computes the L-moments of the data and the parameters of the Exponential distribution and in turn computes the L-moments from the fitted parameters.

Usage

```
lmom.test.exp(data)
```

Arguments

`data`	A vector of data.

Value

Comparison of the median of the distribution and reverse computation of the median from the 0.5 nonexceedance probability.

Output from `lmom.diff`.

Author(s)

W.H. Asquith

See Also

`lmomexp`, `parexp`

Examples

```
lmom.test.exp(c(123,34,4,654,37,78))

lmom.test.exp(rnorm(50))
```

---

lmom.test.gam *Test L-moment and Parameter Algorithms of the Gamma Distribution*

Description

This function computes the L-moments of the data and the parameters of the Gamma distribution and in turn computes the L-moments from the fitted parameters.

Usage

```
lmom.test.gam(data)
```

Arguments

`data`	A vector of data.

Value

Comparison of the median of the distribution and reverse computation of the median from the 0.5 nonexceedance probability.

Output from `lmom.diff`.

Author(s)

W.H. Asquith

See Also

`lmomgam`, `pargam`

Examples

```
lmom.test.gam(c(123,34,4,654,37,78))

lmom.test.gam(rnorm(50))
```

lmom.test.gev — *Test L-moment and Parameter Algorithms of the Generalized Extreme Value Distribution*

Description

This function computes the L-moments of the data and the parameters of the Generalized Extreme Value distribution and in turn computes the L-moments from the fitted parameters.

Usage

```
lmom.test.gev(data)
```

Arguments

`data`	A vector of data.

Value

Comparison of the median of the distribution and reverse computation of the median from the 0.5 nonexceedance probability.

Output from `lmom.diff`.

Author(s)

W.H. Asquith

See Also

`lmomgev`, `pargev`

Examples

```
lmom.test.gev(c(123,34,4,654,37,78))

lmom.test.gev(rnorm(50))
```

lmom.test.glo — *Test L-moment and Parameter Algorithms of the Generalized Logistic Distribution*

Description

This function computes the L-moments of the data and the parameters of the Generalized Logistic distribution and in turn computes the L-moments from the fitted parameters.

Usage

```
lmom.test.glo(data)
```

Arguments

`data`	A vector of data.

Value

Comparison of the median of the distribution and reverse computation of the median from the 0.5 nonexceedance probability.

Output from `lmom.diff`.

Author(s)

W.H. Asquith

See Also

`lmomglo`, `parglo`

Examples

```
lmom.test.glo(c(123,34,4,654,37,78))

lmom.test.glo(rnorm(50))
```

`lmom.test.gno` *Test L-moment and Parameter Algorithms of the Generalized Normal Distribution*

Description

This function computes the L-moments of the data and the parameters of the Generalized Normal distribution and in turn computes the L-moments from the fitted parameters.

Usage

```
lmom.test.gno(data)
```

Arguments

`data`	A vector of data.

Value

Comparison of the median of the distribution and reverse computation of the median from the 0.5 nonexceedance probability.

Output from `lmom.diff`.

Author(s)

W.H. Asquith

See Also

`lmomgno`, `pargno`

Examples

```
lmom.test.gno(c(123,34,4,654,37,78))

lmom.test.gno(rnorm(50))
```

`lmom.test.gpa` *Test L-moment and Parameter Algorithms of the Generalized Pareto Distribution*

Description

This function computes the L-moments of the data and the parameters of the Generalized Pareto distribution and in turn computes the L-moments from the fitted parameters.

Usage

```
lmom.test.gpa(data)
```

Arguments

`data`	A vector of data.

Value

Comparison of the median of the distribution and reverse computation of the median from the 0.5 nonexceedance probability.

Output from `lmom.diff`.

Author(s)

W.H. Asquith

See Also

`lmomgpa`, `pargpa`

Examples

```
lmom.test.gpa(c(123,34,4,654,37,78))

lmom.test.gpa(rnorm(50))
```

lmom.test.gum *Test L-moment and Parameter Algorithms of the Gumbel Distribution*

Description

This function computes the L-moments of the data and the parameters of the Gumbel distribution and in turn computes the L-moments from the fitted parameters.

Usage

```
lmom.test.gum(data)
```

Arguments

`data`	A vector of data.

Value

Comparison of the median of the distribution and reverse computation of the median from the 0.5 nonexceedance probability.

Output from `lmom.diff`.

Author(s)

W.H. Asquith

See Also

`lmomgum`, `pargum`

Examples

```
lmom.test.gum(c(123,34,4,654,37,78))

lmom.test.gum(rnorm(50))
```

lmom.test.kap *Test L-moment and Parameter Algorithms of the Kappa Distribution*

Description

This function computes the L-moments of the data and the parameters of the Kappa distribution and in turn computes the L-moments from the fitted parameters.

Usage

```
lmom.test.kap(data)
```

Arguments

`data`	A vector of data.

Value

Comparison of the median of the distribution and reverse computation of the median from the 0.5 nonexceedance probability.

Output from `lmom.diff`.

Author(s)

W.H. Asquith

See Also

`lmomkap`, `parkap`

Examples

```
lmom.test.kap(c(123,34,4,654,37,78))

lmom.test.kap(rnorm(50))
```

---

lmom.test.nor — *Test L-moment and Parameter Algorithms of the Normal Distribution*

Description

This function computes the L-moments of the data and the parameters of the Normal distribution and in turn computes the L-moments from the fitted parameters.

Usage

```
lmom.test.nor(data)
```

Arguments

`data`	A vector of data.

Value

Comparison of the median of the distribution and reverse computation of the median from the 0.5 nonexceedance probability.

Output from `lmom.diff`.

Author(s)

W.H. Asquith

See Also

`lmomnor`, `parnor`

Examples

```
lmom.test.nor(c(123,34,4,654,37,78))

lmom.test.nor(rnorm(50))
```

---

lmom.test.pe3 — *Test L-moment and Parameter Algorithms of the Pearson Type III Distribution*

Description

This function computes the L-moments of the data and the parameters of the Pearson Type III distribution and in turn computes the L-moments from the fitted parameters.

Usage

```
lmom.test.pe3(data)
```

Arguments

`data`	A vector of data.

Value

Comparison of the median of the distribution and reverse computation of the median from the 0.5 nonexceedance probability.

Output from `lmom.diff`.

Author(s)

W.H. Asquith

See Also

`lmompe3`, `parpe3`

Examples

```
lmom.test.pe3(c(123,34,4,654,37,78))

lmom.test.pe3(rnorm(50))
```

lmom.test.wak — *Test L-moment and Parameter Algorithms of the Wakeby Distribution*

Description

This function computes the L-moments of the data and the parameters of the Wakeby distribution and in turn computes the L-moments from the fitted parameters.

Usage

```
lmom.test.wak(data)
```

Arguments

`data`	A vector of data.

Value

Comparison of the median of the distribution and reverse computation of the median from the 0.5 nonexceedance probability.

Output from `lmom.diff`.

Author(s)

W.H. Asquith

See Also

`lmomwak`, `parwak`

Examples

```
lmom.test.wak(c(123,34,4,654,37,78))

lmom.test.wak(rnorm(50))
```

lmom.ub — *Unbiased L-moments by Direct Sample Estimators*

Description

Unbiased L-moments are computed for a vector using the direct sample estimation method as opposed to the use of probability weighted moments. The mean, L-scale, coefficient of L-variation (τ, L-CV, L-scale/mean), L-skew (τ_3, TAU3, L3/L2), L-kurtosis (τ_4, TAU4, L4/L2), and τ_5 (TAU5, L4/L2) are computed. In conventional nomenclature, the L-moments are

$$\lambda_1 = L1 = \text{mean}$$

$$\lambda_2 = L2 = \text{L-scale}$$

$$\lambda_3 = L3 = \text{third L-moment}$$

$$\lambda_4 = L4 = \text{fourth L-moment}$$

$$\lambda_5 = L5 = \text{fifth L-moment}$$

$$\tau = LCV = \lambda_2/\lambda_1 = \text{coefficient of L-variation}$$

$$\tau_3 = TAU3 = \lambda_3/\lambda_2 = \text{L-skew}$$

$$\tau_4 = TAU4 = \lambda_4/\lambda_2 = \text{L-kurtosis}$$

$$\tau_5 = TAU5 = \lambda_5/\lambda_2 = \text{not named}$$

Usage

```
lmom.ub(x)
```

Arguments

`x`	a vector of data values

Details

The L-moment ratios (τ, τ_3, τ_4, and τ_5) are the primary higher L-moments for application, such as for distribution parameter estimation. However, the actual L-moments (λ_3, λ_4, and λ_5) are also reported. This implementation of L-moment calculation requires a minimum of five data points.

Value

An R `list` is returned.

`L1`	Arithmetic mean.
`L2`	L-scale–analogous to standard deviation.
`LCV`	coefficient of L-variation–analogous to coe. of variation.
`TAU3`	The third L-moment ratio or L-skew–analogous to skew.
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
`TAU5`	The fifth L-moment ratio.
`L3`	The third L-moment.
`L4`	The fourth L-moment.
`L5`	The fifth L-moment.

Author(s)

W.H. Asquith

Source

The Perl code base of W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

Wang, Q.J., 1996b, Direct sample estimators of L-moments: Water Resources Research, vol. 32, no. 12., pp. 3617-3619.

See Also

`lmom2pwm`, `pwm.ub`, `pwm2lmom`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))

lmom.ub(rnorm(100))
```

`lmomwak` — *L-moments of the Wakeby Distribution*

Description

This function estimates the L-moments of the Wakeby distribution given the parameters (ξ, α, β, γ, and δ) from `parwak`. The L-moments in terms of the parameters are complicated and solved numerically.

Usage

```
lmomwak(wakpara)
```

Arguments

`wakpara`	The parameters of the distribution.

Value

An R `list` is returned.

`L1`	Arithmetic mean.
`L2`	L-scale–analogous to standard deviation.
`LCV`	coefficient of L-variation–analogous to coe. of variation.
`TAU3`	The third L-moment ratio or L-skew–analogous to skew.
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
`TAU5`	The fifth L-moment ratio.
`L3`	The third L-moment.
`L4`	The fourth L-moment.
`L5`	The fifth L-moment.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`parwak`, `quawak`, `cdfwak`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
lmr
lmomwak(parwak(lmr))
```

`lmrdia` *L-moment Ratio Diagram Components*

Description

This function returns a list of the L-skew and L-kurtosis (τ_3 and τ_4, respectively) ordinates for construction of L-moment Ratio (L-moment diagrams) that are useful in selecting a distribution to model the data.

Usage

```
lmrdia()
```

Value

An R `list` is returned.

`limits`	The theoretical limits of τ_3 and τ_4–below τ_4 are theoretically not possible.
`exp`	τ_3 and τ_4 of the Exponential distribution.
`gam`	τ_3 and τ_4 of the Gamma distribution.
`gev`	τ_3 and τ_4 of the Generalized Extreme Value distribution.
`glo`	τ_3 and τ_4 of the Generalized Logistic distribution.
`gpa`	τ_3 and τ_4 of the Generalized Pareto distribution.
`gum`	τ_3 and τ_4 of the Gumbel distribution.
`lognormal`	τ_3 and τ_4 of the Lognormal distribution.
`nor`	τ_3 and τ_4 of the Normal distribution.
`pe3`	τ_3 and τ_4 of the Pearson Type III distribution.
`uniform`	τ_3 and τ_4 of the uniform distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`plotlmrdia`

Examples

```
lratios <- lmrdia()
```

`nonexceeds` *Common Nonexceedance Probabilities*

Description

This function returns a vector nonexceedance probabilities.

Usage

```
nonexceeds()
```

Value

A vector of selected nonexceedance probabilities useful in assessing the "frequency curve" in hydrologic applications (noninclusive). The nonexceedance probabilities extend further into the right-hand tail of the "distribution" to the 0.996 and 0.998 nonexceedance probability values as these are equivalent to the 250- and 500-year events respectively. The relation between annual recurrence interval and nonexceedance probability (when annual data are analyzed) is

$$F = 1 - \frac{1}{T}$$

where T is the T-year event.

Author(s)

W.H. Asquith

See Also

quaexp, quagam, quagev, quaglo, quagno, quagpa, quagum, quakap, quanor, quape3, quawak

Examples

```
lmr <- lmom.ub(rnorm(20))
para <- parnor(lmr)
quanor(nonexceeds(),para)
```

---

par2cdf — *Cumulative Distribution Function of the Distributions*

Description

This function acts as a front end of dispatcher to the distribution-specific cumulative distribution functions. The Generalized Lambda distribution is not supported by this function.

Usage

```
par2cdf(x,para)
```

Arguments

x	A real value.
para	The parameters from lmom2par or similar.

Value

Nonexceedance probability ($0 \leq F \leq 1$) for x.

Author(s)

W.H. Asquith

See Also

par2qua, lmom2par

Examples

```
lmr        <- lmom.ub(rnorm(20))
para       <- parnor(lmr)
nonexceed <- par2cdf(0,para)
```

---

par2lmom *Convert the Parameters of a Distribution to the L-moments*

Description

This function converts the parameters of a distribution to the L-moment as represented in an L-moment object. This function dispatches to `lmomCCC` where CCC represents the three character distribution identifier: `exp`, `gam`, `gev`, `glo`, `gno`, `gpa`, `gum`, `kap`, `nor`, `pe3`, and `wak`.

Usage

```
par2lmom(para)
```

Arguments

`para`	A parameter object of a distribution.

Value

An L-moment object (an R `list`) is returned.

Author(s)

W.H. Asquith

See Also

lmom.ub, lmom2par

Examples

```
lmr      <- lmom.ub(rnorm(20))
para     <- parnor(lmr)
frompara <- par2lmom(para)
lmom.diff(frompara,lmr)
```

`par2qua` *Quantile Function of the Distributions*

Description

This function acts as a front end or dispatcher to the distribution-specific quantile functions.

Usage

```
par2qua(f,para)
```

Arguments

`f`	Nonexceedance probability ($0 \leq F \leq 1$).
`para`	The parameters from `lmom2par` or similar.

Value

Quantile value for F.

Author(s)

W.H. Asquith

See Also

`par2cdf`, `lmom2par`

Examples

```
lmr     <- lmom.ub(rnorm(20))
para    <- parnor(lmr)
median  <- par2qua(0.5,para)
```

`parexp` *Estimate the Parameters of the Exponential Distribution*

Description

This function estimates the parameters of the Exponential distribution given the L-moments of the data in an L-moment object such as that returned by `lmom.ub`.

Usage

```
parexp(lmom)
```

Arguments

`lmom`	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

An R `list` is returned.

`type`	The type of distribution: `exp`.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `lmomexp`, `cdfexp`, `quaexp`

Examples

```
lmr <- lmom.ub(rnorm(20))
parexp(lmr)
```

---

pargam *Estimate the Parameters of the Gamma Distribution*

Description

This function estimates the parameters of the Gamma distribution given the L-moments of the data in an L-moment object such as that returned by `lmom.ub`.

Usage

```
pargam(lmom)
```

Arguments

`lmom`	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

An R `list` is returned.

`type`	The type of distribution: `gam`.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `lmomgam`, `cdfgam`, `quagam`

Examples

```
lmr <- lmom.ub(rnorm(20))
pargam(lmr)
```

---

pargev — *Estimate the Parameters of the Generalized Extreme Value Distribution*

Description

This function estimates the parameters of the Generalized Extreme Value distribution given the L-moments of the data in an L-moment object such as that returned by `lmom.ub`.

Usage

```
pargev(lmom)
```

Arguments

`lmom`	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

An R `list` is returned.

`type`	The type of distribution: `gev`.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `lmomgev`, `cdfgev`, `quagev`

Examples

```
lmr <- lmom.ub(rnorm(20))
pargev(lmr)
```

`parglo` *Estimate the Parameters of the Generalized Logistic Distribution*

Description

This function estimates the parameters of the Generalized Logistic distribution given the L-moments of the data in an L-moment object such as that returned by `lmom.ub`.

Usage

```
parglo(lmom)
```

Arguments

`lmom`	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

An R `list` is returned.

`type`	The type of distribution: `glo`.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `lmomglo`, `cdfglo`, `quaglo`

Examples

```
lmr <- lmom.ub(rnorm(20))
parglo(lmr)
```

---

pargno — *Estimate the Parameters of the Generalized Normal Distribution*

Description

This function estimates the parameters of the Generalized Normal (log-Normal) distribution given the L-moments of the data in an L-moment object such as that returned by `lmom.ub`.

Usage

```
pargno(lmom)
```

Arguments

`lmom`	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

An R `list` is returned.

`type`	The type of distribution: `gno`.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `lmomgno`, `cdfgno`, `quagno`

Examples

```
lmr <- lmom.ub(rnorm(20))
pargno(lmr)
```

pargpa *Estimate the Parameters of the Generalized Pareto Distribution*

Description

This function estimates the parameters of the Generalized Pareto distribution given the L-moments of the data in an L-moment object such as that returned by `lmom.ub`.

Usage

```
pargpa(lmom)
```

Arguments

`lmom`	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

An R `list` is returned.

`type`	The type of distribution: `gpa`.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `lmomgpa`, `cdfgpa`, `quagpa`

Examples

```
lmr <- lmom.ub(rnorm(20))
pargpa(lmr)
```

`pargum` *Estimate the Parameters of the Gumbel Distribution*

Description

This function estimates the parameters of the Gumbel distribution given the L-moments of the data in an L-moment object such as that returned by `lmom.ub`.

Usage

```
pargum(lmom)
```

Arguments

`lmom`	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

An R `list` is returned.

`type`	The type of distribution: `gum`.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `lmomgum`, `cdfgum`, `quagum`

Examples

```
lmr <- lmom.ub(rnorm(20))
pargum(lmr)
```

parkap	*Estimate the Parameters of the Kappa Distribution*

Description

This function estimates the parameters of the Kappa distribution given the L-moments of the data in an L-moment object such as that returned by `lmom.ub`.

Usage

```
parkap(lmom)
```

Arguments

`lmom`	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

An R `list` is returned.

`type`	The type of distribution: `kap`.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `lmomkap`, `cdfkap`, `quakap`

Examples

```
lmr <- lmom.ub(rnorm(20))
parkap(lmr)
```

parnor *Estimate the Parameters of the Normal Distribution*

Description

This function estimates the parameters of the Normal distribution given the L-moments of the data in an L-moment object such as that returned by `lmom.ub`.

Usage

```
parnor(lmom)
```

Arguments

`lmom`	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

An R `list` is returned.

`type`	The type of distribution: `nor`.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `lmomnor`, `cdfnor`, `quanor`

Examples

```
lmr <- lmom.ub(rnorm(20))
parnor(lmr)
```

parpe3 *Estimate the Parameters of the Pearson Type III Distribution*

Description

This function estimates the parameters of the Pearson Type III distribution given the L-moments of the data in an L-moment object such as that returned by `lmom.ub`.

Usage

```
parpe3(lmom)
```

Arguments

`lmom`	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

An R `list` is returned.

`type`	The type of distribution: `pe3`.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `lmompe3`, `cdfpe3`, `quape3`

Examples

```
lmr <- lmom.ub(rnorm(20))
parpe3(lmr)
```

parwak — *Estimate the Parameters of the Wakeby Distribution*

Description

This function estimates the parameters of the Wakeby distribution given the L-moments of the data in an L-moment object such as that returned by `lmom.ub`.

Usage

```
parwak(lmom)
```

Arguments

`lmom`	A L-moment object created by `lmom.ub` or `pwm2lmom`.

Value

An R `list` is returned.

`type`	The type of distribution: `wak`.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `lmomwak`, `cdfwak`, `quawak`

Examples

```
lmr <- lmom.ub(rnorm(20))
parwak(lmr)
```

plotlmrdia — *Plot L-moment Ratio Diagram*

Description

Plot the L-moment ratio diagram of L-skew and L-kurtosis from an L-moment ratio diagram object returned by `lmrdia`. This diagram is useful for selecting a distribution to model the data. The application of L-moment diagrams is well documented in the literature. This function is intended to function as a demonstration of L-moment diagram plotting. It is expected that users will “roll their own”.

Usage

```
plotlmrdia(lmr, nopoints=FALSE, nolines=FALSE, nolimits=FALSE,
           nogev=FALSE, noglo=FALSE, nogpa=FALSE, nope3=FALSE, nogno=FALSE,
           noexp=FALSE, nonor=FALSE, nogum=FALSE, nouni=FALSE, ...)
```

Arguments

`lmr`	L-moment diagram object from `lmrdia`.
`nopoints`	If `TRUE` then point distributions are not drawn.
`nolines`	If `TRUE` then line distributions are not drawn.
`nolimits`	If `TRUE` then theoretical limits of L-moments are not drawn.
`nogev`	If `TRUE` then line of Generalized Extreme Value distribution is not drawn.
`noglo`	If `TRUE` then line of Generalized Logistic distribution is not drawn.
`nogno`	If `TRUE` then line of Generalized Normal (log-Normal) distribution is not drawn.
`nogpa`	If `TRUE` then line of Generalized Pareto distribution is not drawn.
`nope3`	If `TRUE` then line of Pearson Type III distribution is not drawn.
`noexp`	If `TRUE` then point of Exponential distribution is not drawn.
`nonor`	If `TRUE` then point of Normal distribution is not drawn.
`nogum`	If `TRUE` then point of Gumbel distribution is not drawn.
`nouni`	If `TRUE` then point of Uniform distribution is not drawn.
`...`	Additional arguments passed onto the `plot` function.

Note

This function provides hardwired calls to `lines` and `points` to produce the diagram. The plot symbology for the shown distributions is summarized here. The Kappa (four parameter) and Wakeby (five parameter) distributions are not well represented on the diagram as each constitute an area (Kappa) or hyperplane (Wakeby) and not a line (three-parameter distributions) or a point (two-parameter distributions). However, the Kappa demarks the area bounded by the Generalized Logistic (`glo`) on the top and the theoretical L-moment limits on the bottom.

GRAPHIC TYPE	GRAPHIC NATURE
L-moment Limits	line width 2 and color 8 (grey)
Generalized Extreme Value	line width 1, line type 2 (dash), and color 2 (red)
Generalized Logistic	line width 1 and color 3 (green)

Generalized Normal	line width 1, line type 2 (dash), and color 4 (blue)
Generalized Pareto	line width 1 and color 4 (blue)
Pearson Type III	line width 1 and color 6 (purple)
Exponential	symbol 16 (filled circle) and color 2 (red)
Normal	symbol 15 (filled square) and color 2 (red)
Gumbel	symbol 17 (filled triangle) and color 2 (red)
Uniform	symbol 18 (filled diamond) and color 2 (red)

Author(s)

W.H. Asquith

References

Asquith, W.H., 1998, Depth-duration frequency of precipitation for Texas: U.S. Geological Survey Water-Resources Investigations Report 98-4044, 107 p.

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

Vogel, R.M., and Fennessey, N.M., 1993, L moment diagrams should replace product moment diagrams: Water Resources Research, vol. 29, no. 6, pp. 1745-1752.

See Also

`lmrdia`

Examples

```
plotlmrdia(lmrdia())
```

`pwm2lmom` *Probability-Weighted Moments to L-moments*

Description

Converts the Probability-Weighted Moments (PWM) to the L-moments given the PWM. The conversion is linear so procedures based on PWMs and identical to those based on L-moments.

$$\lambda_1 = \beta_0$$

$$\lambda_2 = 2\beta_1 - \beta_0$$

$$\lambda_3 = 6\beta_2 - 6\beta_1 + \beta_0$$

$$\lambda_4 = 20\beta_3 - 30\beta_2 + 12\beta_1 - \beta_0$$

$$\lambda_5 = 70\beta_4 - 140\beta_3 + 90\beta_2 - 20\beta_1 + \beta_0$$

$$\tau = \lambda_2/\lambda_1$$

$$\tau_3 = \lambda_3/\lambda_2$$

$$\tau_4 = \lambda_4/\lambda_2$$

$$\tau_5 = \lambda_5/\lambda_2$$

Usage

```
pwm2lmom(pwm)
```

Arguments

`pwm`	A PWM object created by `pwm.ub` or similar.

Details

The Probability Weighted Moments (PWMs) are linear combinations of the L-moments and therefore contain the same statistical information of the data as the L-moments. However, the PWMs are harder to interpret as measures of probability distributions.

Value

An R `list` is returned.

`L1`	Arithmetic mean
`L2`	L-scale–analogous to standard deviation
`LCV`	coefficient of L-variation–analogous to coe. of variation
`TAU3`	The third L-moment ratio or L-skew–analogous to skew
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis
`TAU5`	The fifth L-moment ratio
`L3`	The third L-moment
`L4`	The fourth L-moment
`L5`	The fifth L-moment

Author(s)

W.H. Asquith

References

Greenwood, J.A., Landwehr, J.M., Matalas, N.C., and Wallis, J.R., 1979, Probability weighted moments–Definition and relation to parameters of several distributions expressable in inverse form: Water Resources Research, vol. 15, p. 1,049-1,054.

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`lmom.ub`, `pwm.ub`, `lmom2pwm`

Examples

```
lmom <- pwm2lmom(pwm.ub(c(123,34,4,654,37,78)))

pwm2lmom(pwm.ub(rnorm(100)))
```

`pwm.gev` *Generalized Extreme Value Plotting Position Probability-Weighted Moments*

Description

Generalized Extreme Value plotting position Probability-Weighted Moments (PWMs) are computed from a sample. The first five β_r's are computed. The plotting position formula for the Generalized Extreme Value distribution is

$$p_i = \frac{i - 0.35}{n}$$

where pp_i is the nonexceedance probability F of the ith ascending data values. The parameters A and B together specify the plotting position type, and n is the sample size. The PWMs are computed by

$$\beta_r = n^{-1} \sum_{i=1}^{n} p_i^r \times X_{j:n}$$

where $X_{j:n}$ is the jth order statistic $X_{1:n} \leq X_{2:n} \leq X_{j:n} \ldots \leq X_{n:n}$ of random variable X, and r is $0, 1, 2, \ldots$.

Finally, `pwm.gev` dispatches to `pwm.pp(data,A=-0.35,B=0)` and does not have its own logic.

Usage

```
pwm.gev(x)
```

Arguments

`x`	A vector of data values.

Value

An R `list` is returned.

`BETA0`	The first PWM–equal to the arithmetic mean.
`BETA1`	The second PWM.
`BETA2`	The third PWM.
`BETA3`	The fourth PWM.
`BETA4`	The fifth PWM.

Author(s)

W.H. Asquith

References

Greenwood, J.A., Landwehr, J.M., Matalas, N.C., and Wallis, J.R., 1979, Probability weighted moments–Definition and relation to parameters of several distributions expressable in inverse form: Water Resources Research, vol. 15, p. 1,049-1,054.

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`pwm.ub`, `pwm.pp`, `pwm2lmom`

Examples

```
pwm <- pwm.gev(rnorm(20))
```

`pwm.pp` *Plotting Position Probability-Weighted Moments*

Description

Plotting position Probability-Weighted Moments (PWMs) are computed from a sample. The first five β_r's are computed. The plotting position formula is

$$p_i = \frac{i + A}{n + B}$$

where pp_i is the nonexceedance probability F of the ith ascending data values. The parameters A and B together specify the plotting position type, and n is the sample size. The PWMs are computed by

$$\beta_r = n^{-1} \sum_{i=1}^{n} p_i^r \times X_{j:n}$$

where $X_{j:n}$ is the jth order statistic $X_{1:n} \leq X_{2:n} \leq X_{j:n} \ldots \leq X_{n:n}$ of random variable X, and r is $0, 1, 2, \ldots$.

Usage

```
pwm.pp(x,A,B)
```

Arguments

`x`	A vector of data values.
`A`	A value for the plotting position formula.
`B`	Another value for the plotting position formula.

Value

An R `list` is returned.

`BETA0`	The first PWM–equal to the arithmetic mean.
`BETA1`	The second PWM.
`BETA2`	The third PWM.
`BETA3`	The fourth PWM.
`BETA4`	The fifth PWM.

Author(s)

W.H. Asquith

References

Greenwood, J.A., Landwehr, J.M., Matalas, N.C., and Wallis, J.R., 1979, Probability weighted moments–Definition and relation to parameters of several distributions expressable in inverse form: Water Resources Research, vol. 15, p. 1,049-1,054.

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Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`pwm.ub`, `pwm.gev`, `pwm2lmom`

Examples

```
pwm <- pwm.pp(rnorm(20),A=-0.35,B=0)
```

`pwm.ub` *Unbiased Probability-Weighted Moments*

Description

Unbiased Probability-Weighted Moments (PWMs) are computed from a sample. The first five β_r's are computed. The unbiased PWMs are computed by the the plotting position formulation by a call to `pwm.pp{data,A=0,B=0}`. The plotting position formula is

$$p_i = \frac{i + A}{n + B}$$

where pp_i is the nonexceedance probability F of the ith ascending data values. The parameters A and B together specify the plotting position type, and n is the sample size. The PWMs are computed by

$$\beta_r = n^{-1} \sum_{i=1}^{n} p_i^r \times X_{j:n}$$

where $X_{j:n}$ is the jth order statistic $X_{1:n} \leq X_{2:n} \leq X_{j:n} \ldots \leq X_{n:n}$ of random variable X, and r is $0, 1, 2, \ldots$.

Usage

```
pwm.ub(x)
```

Arguments

`x`	A vector of data values.

Value

An R `list` is returned.

`BETA0`	The first PWM–equal to the arithmetic mean.
`BETA1`	The second PWM.
`BETA2`	The third PWM.
`BETA3`	The fourth PWM.
`BETA4`	The fifth PWM.

Author(s)

W.H. Asquith

References

Greenwood, J.A., Landwehr, J.M., Matalas, N.C., and Wallis, J.R., 1979, Probability weighted moments–Definition and relation to parameters of several distributions expressable in inverse form: Water Resources Research, vol. 15, p. 1,049-1,054.

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`pwm.pp`, `pwm.gev`, `pwm2lmom`

Examples

```
pwm <- pwm.ub(rnorm(20))
```

`quacau` *Quantile Function of the Cauchy Distribution*

Description

This function computes the quantiles of the Cauchy distribution given parameters (ξ and α) of the distribution provided by `vec2par`. The quantile function of the distribution is

$$x(F) = \xi + \alpha \times atan(\pi * (F - 0.5))$$

where $x(F)$ is the quantile for nonexceedance probability F, ξ is a location parameter and α is a scale parameter. R supports the quantile function of the Cauchy distribution through `qcauchy`. This function does not use `qcauchy` because `qcauchy` does not return `Inf` for $F = 1$ although it returns `-Inf` for $F = 0$.

Usage

```
quacau(f, para)
```

Arguments

`f`	Nonexceedance probability ($0 \leq F \leq 1$).
`para`	The parameters from `vec2par` or similar.

Value

Quantile value for for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Gilchirst, W.G., 2000, Statistical modeling with quantile functions: Chapman and Hall/CRC, Boca Raton, FL.

See Also

cdfcau, vec2par

Examples

```
para <- c(12,12)
quacau(.5,vec2par(para,type='cau'))
```

---

quaexp — *Quantile Function of the Exponential Distribution*

Description

This function computes the quantiles of the Exponential distribution given parameters (ξ and α) of the distribution computed by parexp. The quantile function of the distribution is

$$x(F) = \xi - \alpha \log(1 - F)$$

where $x(F)$ is the quantile for nonexceedance probability F, ξ is a location parameter and α is a scale parameter.

Usage

```
quaexp(f, para)
```

Arguments

f	Nonexceedance probability ($0 \leq F \leq 1$).
para	The parameters from parexp or similar.

Value

Quantile value for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

cdfexp, parexp

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
quaexp(0.5,parexp(lmr))
```

---

quagam — *Quantile Function of the Gamma Distribution*

Description

This function computes the quantiles of the Gamma distribution given parameters (α and β) of the distribution computed by pargam. The quantile function has no explicit form. See the qgamma function. The parameters have the following interpretations: α is a shape parameter and β is a scale parameter in the R syntax.

Usage

```
quagam(f, para)
```

Arguments

f	Nonexceedance probability ($0 \leq F \leq 1$).
para	The parameters from pargam or similar.

Value

Quantile value for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

cdfgam, pargam

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
quagam(0.5,pargam(lmr))
```

quagev	*Quantile Function of the Generalized Extreme Value Distribution*

Description

This function computes the quantiles of the Generalized Extreme Value distribution given parameters (ξ, α, and κ) of the distribution computed by `pargev`. The quantile function of the distribution is

$$x(F) = \xi + \frac{\alpha}{\kappa}(1 - (-log(F))^{\kappa})$$

for $\kappa \neq 0$

$$x(F) = \xi - \alpha log(-log(F))$$

for $\kappa = 0$

where $x(F)$ is the quantile for nonexceedance probability F, ξ is a location parameter, α is a scale parameter, and κ is a shape parameter.

Usage

```
quagev(f, para)
```

Arguments

`f`	Nonexceedance probability ($0 \leq F \leq 1$).
`para`	The parameters from `pargev` or similar.

Value

Quantile value for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`cdfgev`, `pargev`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
quagev(0.5,pargev(lmr))
```

quagld *Quantile Function of the Generalized Lambda Distribution*

Description

This function computes the quantiles of the Generalized Lambda distribution given parameters (Λ_1, Λ_2, Λ_3, and Λ_4) of the distribution computed by `vec2par`. The quantile function of the distribution is

$$x(F) = \Lambda_1 + \frac{F^{\Lambda_3} - (1-F)^{\Lambda_4}}{\Lambda_2}$$

where $x(F)$ is the quantile for nonexceedance probability F, Λ_1 is a location parameter, Λ_2 is a scale parameter, and Λ_3, and Λ_4 are shape parameters.

Usage

```
quagld(f, gldpara)
```

Arguments

`f`	Nonexceedance probability ($0 \leq F \leq 1$).
`gldpara`	The parameters from `vec2par` or similar.

Value

Quantile value for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Karian, Z.A., and Dudewicz, E.J., 2000, Fitting statistical distributions– The generalized lambda distribution and generalized bootstrap methods: CRC Press, Boca Raton, FL, 438 p.

See Also

Examples

```
para <- vec2par(c(123,34,4,3),type="gld")
quawak(0.5,para)
```

quaglo *Quantile Function of the Generalized Logistic Distribution*

Description

This function computes the quantiles of the Generalized Logistic distribution given parameters (ξ, α, and κ) of the distribution computed by parglo. The quantile function of the distribution is

$$x(F) = \xi + \frac{\alpha}{\kappa}\left(1 - \left(\frac{1-F}{F}\right)^{\kappa}\right)$$

for $\kappa \neq 0$

$$x(F) = \xi - \alpha \log\left(\frac{1-F}{F}\right)$$

for $\kappa = 0$

where $x(F)$ is the quantile for nonexceedance probability F, ξ is a location parameter, α is a scale parameter, and κ is a shape parameter.

Usage

```
quaglo(f, para)
```

Arguments

f	Nonexceedance probability ($0 \leq F \leq 1$).
para	The parameters from parglo or similar.

Value

Quantile value for for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

cdfglo, parglo

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
quaglo(0.5,parglo(lmr))
```

`quagno` *Quantile Function of the Generalized Normal Distribution*

Description

This function computes the quantiles of the Generalized Normal (log-Normal) distribution given parameters (xi, α, and κ) of the distribution computed by `pargno`. The quantile function of the distribution has no explicit form. The parameters have the following interpretations: ξ is a location parameter, α is a scale parameter, and κ is a shape parameter.

Usage

```
quagno(f, para)
```

Arguments

`f`	Nonexceedance probability ($0 \leq F \leq 1$).
`para`	The parameters from `pargno` or similar.

Value

Quantile value for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`cdfgno`, `pargno`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
quagno(0.5,pargno(lmr))
```

quagpa — *Quantile Function of the Generalized Pareto Distribution*

Description

This function computes the quantiles of the Generalized Pareto distribution given parameters (ξ, α, and κ) of the distribution computed by `pargpa`. The quantile function of the distribution is

$$x(F) = \xi + \frac{\alpha}{\kappa}(1 - (1 - F)^{\kappa})$$

for $\kappa \neq 0$

$$x(F) = \xi - \alpha \log(1 - F)$$

for $\kappa = 0$

where $x(F)$ is the quantile for nonexceedance probability F, ξ is a location parameter, α is a scale parameter, and κ is a shape parameter.

Usage

```
quagpa(f, para)
```

Arguments

`f`	Nonexceedance probability ($0 \leq F \leq 1$).
`para`	The parameters from `pargpa` or similar.

Value

Quantile value for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`cdfgpa`, `pargpa`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
quagpa(0.5,pargpa(lmr))
```

quagum	*Quantile Function of the Gumbel Distribution*

Description

This function computes the quantiles of the Gumbel distribution given parameters (ξ and α) of the distribution computed by `pargum`. The quantile function of the distribution is

$$x(F) = \xi - \alpha \log(-\log(F))$$

where $x(F)$ is the quantile for nonexceedance probability F, ξ is a location parameter, and α is a scale parameter.

Usage

```
quagum(f, para)
```

Arguments

`f`	Nonexceedance probability ($0 \leq F \leq 1$).
`para`	The parameters from `pargum` or similar.

Value

Quantile value for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`cdfgum`, `pargum`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
quagum(0.5,pargum(lmr))
```

quakap *Quantile Function of the Kappa Distribution*

Description

This function computes the quantiles of the Kappa distribution given parameters (ξ, α, κ, and h) of the distribution computed by `parkap`. The quantile function of the distribution is

$$x(F) = \xi + \frac{\alpha}{\kappa}\left(1 - \left(\frac{1 - F^h}{h}\right)^\kappa\right)$$

where $x(F)$ is the quantile for nonexceedance probability f, ξ is a location parameter, α is a scale parameter, κ is a shape parameter, and h is another shape parameter.

Usage

```
quakap(f, para)
```

Arguments

`f`	Nonexceedance probability ($0 \leq F \leq 1$).
`para`	The parameters from `parkap` or similar.

Value

Quantile value for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`cdfkap`, `parkap`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78,21,32,231,23))
quakap(0.5,parkap(lmr))
```

quanor *Quantile Function of the Normal Distribution*

Description

This function computes the quantiles of the Normal distribution given parameters ($mean$ and sd) of the distribution computed by `parnor`. The quantile function of the distribution has no explicit form (see `cdfnor` and `qnorm`). The parameters have the following interpretations: $mean$ is the arithmetic mean and sd is the standard deviation.

Usage

```
quanor(f, para)
```

Arguments

f	Nonexceedance probability ($0 \leq F \leq 1$).
para	The parameters from `parnor` or similar.

Value

Quantile value for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`cdfnor`, `parnor`, `quagno`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
quanor(0.5,parnor(lmr))
```

quape3 *Quantile Function of the Pearson Type III Distribution*

Description

This function computes the quantiles of the Pearson Type III distribution given parameters (ξ, α, and γ) of the distribution computed by `parpe3`. The quantile function of the distribution has no explicit form (see `cdfpe3`). The parameters have the following interpretations: ξ is a location parameter, α is a scale parameter, and γ is a shape parameter.

Usage

```
quape3(f, para)
```

Arguments

`f`	Nonexceedance probability ($0 \le F \le 1$).
`para`	The parameters from `parpe3` or similar.

Value

Quantile value for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`cdfpe3`, `parpe3`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
quape3(0.5,parpe3(lmr))
```

`quawak` *Quantile Function of the Wakeby Distribution*

Description

This function computes the quantiles of the Wakeby distribution given parameters (ξ, α, β, γ, and δ) of the distribution computed by `parwak`. The quantile function of the distribution is

$$x(F) = \xi + \frac{\alpha}{\beta}(1 - (1 - F)^{\beta}) - \frac{\gamma}{\delta}(1 - (1 - F))^{-\delta}$$

where $x(F)$ is the quantile for nonexceedance probability F, ξ is a location parameter, α and β are scale parameters, and γ, and δ are shape parameters. The five returned parameters from `parwak` in order are ξ, α, β, γ, and δ.

Usage

```
quawak(f, wakpara)
```

Arguments

`f`	Nonexceedance probability ($0 \leq F \leq 1$).
`wakpara`	The parameters from `parwak` or similar.

Value

Quantile value for nonexceedance probability F.

Author(s)

W.H. Asquith

References

Hosking, J.R.M., 1990, L-moments–Analysis and estimation of distributions using linear combinations of order statistics: Journal of the Royal Statistical Society, Series B, vol. 52, p. 105-124.

Hosking, J.R.M., 1996, FORTRAN routines for use with the method of L-moments: Version 3, IBM Research Report RC20525, T.J. Watson Research Center, Yorktown Heights, New York.

Hosking, J.R.M. and Wallis, J.R., 1997, Regional frequency analysis–An approach based on L-moments: Cambridge University Press.

See Also

`cdfwak`, `parwak`

Examples

```
lmr <- lmom.ub(c(123,34,4,654,37,78))
quawak(0.5,parwak(lmr))
```

vec2lmom — *Convert a Vector of L-moments to a L-moment Object*

Description

This function converts a vector of L-moments to a L-moment object of this package. The object is an R `list`. This function is intended to facilitate the use of L-moments that the user might have from other sources. The first five L-moments are supported (λ_1, λ_2, λ_3, λ_4, λ_5, τ, τ_3, τ_4, and τ_5). Because in typical practice, the $k \geq 3$ order L-moments are dimensionless ratios (τ_3, τ_4, and τ_5), this function computes λ_3, λ_4, λ_5 from λ_2 and the ratios. However, typical practice is not set on the use of λ_2 or τ as measure of dispersion. Therefore, this function takes an `lscale` optional logical (`TRUE|FALSE`) argument–if λ_2 is provided and `lscale=TRUE`, then τ is computed by the function and if τ is provided, then λ_2 is computed by the function.

Usage

```
vec2lmom(vec,lscale)
```

Arguments

`vec`	A vector of L-moment values in λ_1, λ_2 or τ, τ_3, τ_4, and τ_5 order.
`lscale`	A logical switch on the type of the second value of first argument. L-scale (λ_2) or LCV (τ). Default is `TRUE`, the second value in the first argument is λ_2.

Value

An R `list` is returned.

`L1`	Arithmetic mean.
`L2`	L-scale–analogous to standard deviation.
`LCV`	coefficient of L-variation–analogous to coe. of variation.
`TAU3`	The third L-moment ratio or L-skew–analogous to skew.
`TAU4`	The fourth L-moment ratio or L-kurtosis–analogous to kurtosis.
`TAU5`	The fifth L-moment ratio.
`L3`	The third L-moment.
`L4`	The fourth L-moment.
`L5`	The fifth L-moment.

Author(s)

W.H. Asquith

See Also

`lmom.ub`, `vec2pwm`

Examples

```
lmr <- vec2lmom(c(12,0.6,0.34,0.20,0.05),lscale=FALSE)
```

`vec2par` *Convert a Vector of Parameters to a Parameter Object of a Distribution*

Description

This function converts the L-moments of the data to the parameters of a distribution. The type of distribution is specified in the argument list: `cau`, `exp`, `gam`, `gev`, `glo`, `gno`, `gpa`, `gum`, `kap`, `nor`, `pe3`, and `wak`.

Usage

```
vec2par(vec, type)
```

Arguments

`vec`	A vector of parameter values for the distribution specified by type.
`type`	Three character distribution type (for example, `type='gev'`).

Value

An R `list` is returned.

`type`	The type of distribution in three character format.
`para`	The parameters of the distribution.

Author(s)

W.H. Asquith

See Also

`lmom2par`

Examples

```
para <- vec2par(c(12,123,0.5),'gev')
Q <- quagev(0.5,para)
```

vec2pwm — *Convert a Vector of Probability-Weighted Moments to a Probability-Weighted Moments Object*

Description

This function converts a vector of Probability-Weighted Moments (PWM) to a PWM object of this package. The object is an R `list`. This function is intended to facilitate the use of PWM that the user might have from other sources. The first five PWMs are supported (β_0, β_1, β_2, β_3, β_4).

Usage

```
vec2pwm(vec)
```

Arguments

`vec`	A vector of PWM values in (β_0, β_1, β_2, β_3, β_4) order.

Value

An R `list` is returned.

`BETA0`	The first PWM–equal to the arithmetic mean.
`BETA1`	The second PWM.
`BETA2`	The third PWM.
`BETA3`	The fourth PWM.
`BETA4`	The fifth PWM.

Author(s)

W.H. Asquith

See Also

`vec2lmom`

Examples

```
pwm <- vec2pwm(c(12,123,12,12,54))
```

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