

# Package ‘lmomPi’

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**License** GPL (>= 3)

**Title** (Precipitation) Frequency Analysis and Variability with L-Moments from 'lmom'

**Type** Package

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**Description** It is an extension of 'lmom' R package: 'pel', 'cdf', 'qua' function families are lumped and called from one function per each family respectively in order to create robust automatic tools to fit data with different probability distributions and then to estimate probability values and return periods. The implemented functions are able to manage time series with constant and/or missing values without stopping the execution with error messages. The package also contains tools to calculate several indices based on variability (e.g. 'SPI', Standardized Precipitation Index, see <<https://climatedataguide.ucar.edu/climate-data/standardized-precipitation-index-spi>> and <<http://spei.csic.es/>>) for multiple time series or spatio-temporal gridded values.

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**Depends** R(>= 3.0.1), lmom, stringr

**Suggests** rasterList, lmomRFA, SPEI

**RoxygenNote** 6.0.1

**NeedsCompilation** no

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cdf	<i>Generic function for cdf...: probability distribution fitting with L-Moments.</i>
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### Description

These functions compute value(s) of cumulated probability or SPI-like (normal standardize) index from a sample or time series of  $x$ .

### Usage

```
cdf(para, x, probability_distribution_attrname = "probability_distrib",
     indices = NULL, return.as.spi = FALSE, spi.scale = NA, ...)
```

```
spi.cdf(x, para, ...)
```

```
cdf.spi(x, para, ...)
```

### Arguments

$x$ , para, ...	L-moments and further parameters for <code>cdf...</code> and <code>cdf</code>
probability_distribution_attrname	attribute name for probability distribution
indices	vector of string working as factors or indices, e.g. the month names or similar. It must be of the same length of $x$ or the length equal to 1 other NULL, if not used. If used, it computes cdf for each factor.
return.as.spi	logical parameter. Default is FALSE. If it is TRUE probability value is transformed to a normalized random variable through standard <code>qnorm</code> , as for Standard Precipitation Index (SPI) ( <a href="https://climatedataguide.ucar.edu/climate-data/standardized-precipitation-index-spi">https://climatedataguide.ucar.edu/climate-data/standardized-precipitation-index-spi</a> ).
spi.scale	integer value or NA. If it greater than 1 $x$ is filtered with the sum of a generic element of $x$ and the previous <code>spi.scale-1</code> ones (e.g. SPI-3, SPI-6, etc. ). Default is NA (no filtering) which is equivalent to <code>spi.scale=1</code> .

### See Also

[pe1](#), [cdfexp](#), [cdfgam](#), [cdfgev](#), [cdfglo](#),

[cdfgpa](#), [cdfgno](#), [cdfgum](#), [cdfkap](#), [cdfln3](#), [cdfnor](#), [cdfpe3](#), [cdfwak](#), [cdfwei](#)

**Examples**

```

# Sample L-moments of Ozone from the airquality data
data(airquality)
lmom <- samlmu(airquality$Ozone,nmom=6)

distrib <- c("exp","gam","gev","glo","gpa","gno","gum","kap",
"ln3","nor","pe3","wak","wei")

para_list <- pel(distrib=distrib,lmom=lmom)
cdf_list <- cdf(para=para_list,x=airquality$Ozone)

library(rasterList)
precff <- system.file("map/Mekrou_precipitation.grd", package="rasterList")
prec <- stack(precff)
prec_point <- prec[143][,]

## month index
month <- as.character(as.Date(names(prec_point),format="%Y.%m.%d"),format="M%m")
prec_point[(prec_point<1) & (month=="M01")] <- 0

distrib_prec2 <- c("gam")
para_vvv <- pel(x=prec_point,indices=month,distrib=distrib_prec2)
cdf_ <- cdf(x=prec_point,indices=month,para=para_vvv)
spi_ <- spi.cdf(x=prec_point,indices=month,para=para_vvv)

####
## Not run:
para_raster <- rasterList(prec,FUN=pel_x,indices=month,distrib=distrib_prec2)
spi1_raster <- stack(RasterListApply(x=rasterList(prec),para=para_raster,
indices=list(month),FUN=spi.cdf))

para_raster_spi3 <- rasterList(prec,FUN=pel_x,indices=month,distrib=distrib_prec2,
spi.scale=3)
spi3_raster <- stack(RasterListApply(x=rasterList(prec),para=para_raster_spi3,
indices=list(month),spi.scale=3,FUN=spi.cdf))

## End(Not run)

## Comparison with the SPI/SPEI algorithms: 'SPEI::spi' ('SPEI' package)
library(SPEI)

data(wichita)

distrib_wichita <- 'pe3'
spi.scale <- 1

month_wichita <- sprintf("M%02d",wichita$MONTH)
para_wichita <- pel(x=wichita$PRCP,indices=month_wichita,distrib=distrib_wichita,
spi.scale=spi.scale)
spi_wichita <- spi.cdf(x=wichita$PRCP,indices=month_wichita,para=para_wichita,

```

```
spi.scale=spi.scale)
spi_wichita_speipkg <- spi(data=wichita$PRCP,distrib='PearsonIII',scale=spi.scale)
difference <- spi_wichita-spi_wichita_speipkg$fitted
```

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lmomPi-Package	<i>lmomPi: (Precipitation) Frequency Analysis and Variability with L-Moments from lmom</i>
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## Description

This packages contains wrapper functions of 'lmom' packages : [cdf](#): generic distribution function; [qua](#): generic quantile function; [pel](#): fitting of probability distribution function through L-moments.

## Details

The example functions are illustrated making use of CHIRPS rainfall meteorological data taken:

Funk, Chris, Pete Peterson, Martin Landsfeld, Diego Pedreros, James Verdin, Shraddhanand Shukla, Gregory Husak, James Rowland, Laura Harrison, Andrew Hoell and Joel Michaelsen. "The climate hazards infrared precipitation with stations - a new environmental record for monitoring extremes". Scientific Data 2, 150066. doi:10.1038/sdata.2015.66 2015 , <http://chg.geog.ucsb.edu/data/chirps/>.

The package-provided datasets shall be only used as example datasets.

The package also contains wrapped functions to calculate several indices based on variability (e.g. 'SPI' , Standardized Precipitation Index, see <https://climatedataguide.ucar.edu/climate-data/standardized-precipitation-index-spi> and <http://spei.csic.es>) for multiple time series or spatio-temporal gridded values. The function `spi.cdf` is compared against `SPEI::spi` in `SPEI` package (<https://cran.r-project.org/package=SPEI>). The differences in SPI estimation have order of magnitude averagely about  $10^{-8}$ , due to the different fitting methods implemented in the two packages. (see `SPEI::spi` and `spi.cdf` for more details).

The development of this package has been sponsored by ACEWATER2 and "Water for Growth and Poverty Reduction in the Mekrou" projects of the Joint Research Centre of the European Commission (<https://aquaknow.jrc.ec.europa.eu>).

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pel	<i>Generic function for <a href="#">pel...</a></i>
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## Description

Generic function for [pel...](#): probability distribution fitting with L-Moments

**Usage**

```

pel(distrib = c("exp", "gam", "gev", "glo", "gpa", "gno", "gum", "kap", "ln3",
  "nor", "pe3", "wak", "wei"), lmom = NULL,
  probability_distribution_attrname = "probability_distrib", x = NULL,
  nmom = 5, sort.data = TRUE, ratios = sort.data, trim = 0,
  indices = NULL, spi.scale = NA, ...)

pel_x(x, ...)

pel_lmom(lmom, ...)

```

**Arguments**

distrib	character string incating the probability distribution to fit
lmom, ...	L-moments and further parameters for <a href="#">pel...</a>
probability_distribution_attrname	attribute name for probability distribution
x	vector containg sample. It is utilied to calculete L-moments in case lmom is set equal to NULL.
nmom, sort.data, ratios, trim	arguments for <a href="#">sam1mu</a> (nmom=5 by default). They are utilized if argument lmom is NULL.
indices	optional index or tag character vector of the same length of x used as INDEX for <a href="#">tapply</a> . It is used to fit different probability distribution in one sample time series (e. g. months in an year).
spi.scale	integer value or NA. If it is greater than 1, x is filtered with the sum of a generic element of x and the previous spi.scale-1 ones (e.g. SPI-3,SPI-6, etc. ). Default is NA (no filtering) which is equivalent to spi.scale=1.

**Details**

pel\_x and pel\_lmom are wrapper functions of [pel](#) whose first argument is x or lmom respectively.

**See Also**

[pel...pelexp](#),[pelgam](#),[pelgev](#),[pelglo](#),[pelgpa](#),  
[pelgno](#),[pelgum](#),[pelkap](#),[pelln3](#),[pelnor](#),  
[pelpe3](#),[pelwak](#),[pelwei](#),  
[cdf](#),[qua](#)

**Examples**

```

# Sample L-moments of Ozone from the airquality data
data(airquality)
lmom <- sam1mu(airquality$Ozone,nmom=6)
distrib <- "gev"

```

```

# Fit a GEV distribution
out_gev <- pel(distrib=distrib,lmom=lmom)

distrib <- c("exp", "gam", "gev", "glo", "gpa", "gno", "gum", "kap", "ln3",
"nor", "pe3", "wak", "wei")

out_list <- pel(distrib=distrib,lmom=lmom)

library(rasterList)
precff <- system.file("map/Mekrou_precipitation.grd", package="rasterList")
precs <- stack(precff)
prec_point <- precs[143][,]
## month index
month <- as.character(as.Date(names(prec_point), format="%Y.%m.%d"), format="M%m")
distrib_prec <- c("gam", "pe3")
out_x <- pel(x=prec_point, indices=month, distrib=distrib_prec)
out_spi3_x <- pel(x=prec_point, indices=month, distrib=distrib_prec, spi.scale=3)
distrib_prec2 <- c("gam")
out_x <- pel(x=prec_point, indices=month, distrib=distrib_prec2)
out_spi3_x <- pel(x=prec_point, indices=month, distrib=distrib_prec2, spi.scale=3)

### example with PEL when x is always 0 or a fixed constant
xx <- array(0,50)
out_xx <- pel_x(x=xx, distrib=distrib_prec2)

```

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qua	<i>Generic function for qua...: probability distribution fitting with L-Moments</i>
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## Description

Generic function for qua...: probability distribution fitting with L-Moments

## Usage

```
qua(para, f, probability_distribution_attrname = "probability_distrib", ...)
```

## Arguments

f, para, ... L-moments and further parameters for qua...  
probability\_distribution\_attrname  
attribute name for probability distribution

## See Also

[pel](#), [quaexp](#), [quagam](#), [quagev](#), [quaglo](#), [quagpa](#), [quagno](#), [quagum](#),  
[quakap](#), [qualn3](#), [quanor](#), [quape3](#), [quawak](#), [quawei](#)

**Examples**

```
# Sample L-moments of Ozone from the airquality data
data(airquality)
lmom <- samlmu(airquality$Ozone, nmom=6)

distrib <- c("exp", "gam", "gev", "glo", "gpa", "gno", "gum", "kap", "ln3", "nor",
"pe3", "wak", "wei")

para_list <- pel(distrib=distrib, lmom=lmom)
f <- (1:10)/10
qua_list <- qua(para=para_list, f=f)
```

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