Package 'bootRes'

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Type Package

Title Bootstrapped Response and Correlation Functions

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Description Calculation of Bootstrapped Response and Correlation Functions for Use in Dendroclimatology

License GPL-3

LazyLoad yes

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`bootRes-package` *The bootRes Package for Bootstrapped Response and Correlation Functions*

Description

This package contains functions for calculating bootstrapped response and correlation functions for use in dendroclimatology.

Details

Package:	bootRes
Type:	Package
Version:	0.1
Date:	2009-06-24
License:	GPL-3
LazyLoad:	yes

Function `dcc` is used to calculate response and correlation functions using tree-ring chronologies and monthly climatic data (Fritts, 1976, Cook and Kairiukstis, 1990), `dcplot` is a convenient plotting function for its output. In its current state this package is a clone of the computer programme DENDROCLIM2002 (Biondi and Waikul, 2004).

Author(s)

Christian Zang with significant input from Franco Biondi

Maintainer: Christian Zang <christian.zang@wzw.tum.de>

References

Zang, C., & Biondi, F. (2012) Dendroclimatic calibration in R: The bootRes package for response and correlation function analysis. *Dendrochronologia* doi:10.1016/j.dendro.2012.08.001

Biondi, F. & Waikul, K. (2004) DENDROCLIM2002: A C++ program for statistical calibration of climate signals in tree-ring chronologies. *Computers & Geosciences* 30:303-311

Cook, E.R. and Kairiukstis, L.A. (1990) *Methods of Dendrochronology: Applications in the Environmental Sciences.* Springer

Fritts, H.C. (1976) *Tree ring and climate*. Academic Press

dcc *Response and correlation functions.*

Description

This function calculates response and correlation functions from tree-ring chronologies and monthly climatic data. Function parameters are bootstrapped to calculate their significance and confidence intervals.

Usage

```
dcc(chrono, clim, method = "response", start = -6, end = 9, timespan =
NULL, vnames = NULL, sb = TRUE, boot = TRUE, ci = 0.05)
```

Arguments

chrono	data.frame containing a tree-ring chronologies, e.g. as obtained by chron of package dplR.
clim	data.frame with climatic data in monthly resolution, with year, month and climate parameters in columns. All columns except year and month will be recognized as parameters for response or correlation function.
method	string specifying the calculation method. Possible values are "response" and "correlation". Partial strings are ok.
start	integer value to determine the first month to be used as a predictor in the response or correlation function. A negative value denotes a start month from previous year, a positive value denotes a start month from current year.
end	integer value to determine the last month to be used as a predictor in the response or correlation function. A negative value denotes an end month from previous year, a positive value denotes an end month from current year.
timespan	integer vector of length 2 specifying the time interval (in years) to be considered for analysis. Defaults to the maximum possible interval.
vnames	character vector with variable names. defaults to corresponding column names of data.frame clim.
sb	logical flag indicating whether textual status bar should be suppressed. Suppression is recommended for e.g. Sweave files.
boot	logical flag indicating whether bootstrap resampling is to be performed. If set to FALSE, no significance estimates and confidence intervals are provided.
ci	numerical value to set the test level for significance test (values 0.01, 0.05 and 0.1 are allowed); the confidence intervals are adapted accordingly.

Details

The functions dcc and mdcc clone the functionality of programme DENDROCLIM2002 (Biondi and Waikul, 2004), and will calculate bootstrapped (and non-bootstrapped) moving (mdcc and static (dcc) response and correlation functions in a similar fashion as described in the above mentioned paper.

In case of response function analysis 1000 bootstrap samples are taken from the original distribution and an eigen decomposition of the standardized predictor matrix is performed. Nonrelevant eigenvectors are removed using the PVP criterion (Guiot, 1990), principal component scores are then calculated from the matrices of reduced eigenvectors and standardized climatic predictors. Response coefficients are found via singular value decomposition, and tested for significance using the 95% percentile range method (Dixon, 2001). In case of correlation function analysis, the coefficients are Pearson's correlation coefficients. The same method for significance testing is applied.

Input chronology data can be a data.frame such as produced by function chron of package dplR. It has to be a data.frame with at least one column containing the tree-ring indices, and the corresponding years as rownames.

For climatic input data, there are three possibilities: Firstly, input climatic data can be a data.frame or matrix consisting of at least 3 rows for years, months and at least one climate parameter in the given order. Secondly, input climatic data can be a single data.frame or matrix in the style of the original DENDROCLIM2002 input data, i.e. one parameter with 12 months in one row, where the first column represents the year. Or thirdly, input climatic data can be a list of several of the latter described data.frame or matrices. As an internal format dispatcher checks the format automatically, it is absolutely necessary that in all three cases, only complete years (months 1-12) are provided. It is not possible to mix different formats in one go.

The window for response/correlation function analysis is specified via start and end, where e.g. -4 means previous April etc.

Value

A data.frame with a response/correlation coefficient for each parameter, its significance (coded as 0/1) and its 95% confidence intervall. If boot is set to FALSE, no significance and confidence intevals are computed, the values are set to NA.

Author(s)

Christian Zang

References

Biondi, F. & Waikul, K. (2004) DENDROCLIM2002: A C++ program for statistical calibration of climate signals in tree-ring chronologies. *Computers & Geosciences* 30:303-311

Dixon, P.M. (2001) Bootstrap resampling. In: El-Shaarawi, A.H., Piegorsch, W.W. (Eds.), *The Encyclopedia of Environmetrics*. Wiley, New York.

Guiot, J. (1991) The boostrapped response function. *Tree-Ring Bulletin* 51:39-41

See Also

dcplot

Examples

```
## Not run:
data(muc.clim) # climatic data
data(muc.spruce) # spruce data

# calculate and plot response function
dc.resp <- dcc(muc.spruce, muc.clim)
dcplot(dc.resp)

# calculate and plot correlation function
dc.corr <- dcc(muc.spruce, muc.clim, method = "corr")
dcplot(dc.corr)

# use modelled data for better response ;-)
data(muc.fake)
dc.resp.fake <- dcc(muc.fake, muc.clim)
dcplot(dc.resp.fake)

# use DENDROCLIM2002-style data
data(rt.spruce)
data(rt.temp)
data(rt.prec)
dc.resp <- dcc(rt.spruce, list(rt.temp, rt.prec), vnames =
c("Temperature", "Precipitation"))
dcplot(dc.resp)

## End(Not run)
```

`dcplot` *Plotting Function for Response and Correlation Functions*

Description

A simple plotting function for response and correlation functions derived from dcc.

Usage

```
dcplot(x, ci = TRUE, sig = TRUE, labels = NULL, vertical = FALSE)
```

Arguments

`x`	`data.frame` with coefficients derived from dcc.
`ci`	logical: should confidence intervals be plotted?
`sig`	logical: should significant coefficients be indicated by bars in darker grey?
`labels`	character vector with labels to use for coefficients. Defaults to `rownames(x)`.
`vertical`	logical: should plots be laid out vertically (defaults to FALSE).

Details

An arbitrary number of parameters can be displayed either horizontally or vertically in subplots.

Value

None. Invoked for side effect (plot).

Author(s)

Christian Zang

See Also

dcc

Examples

```
## Not run:
data(muc.clim)
data(muc.spruce)

# calculate and plot bootstrapped correlation function
dc <- dcc(muc.spruce, muc.clim, method = "corr")
dcplot(dc)

## End(Not run)
```

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mdcc *Moving Response and Correlation Functions.*

Description

This function calculates moving response and correlation functions from tree-ring chronologies and monthly climatic data. The calculation is performed repeatedly for consecutive time windows. Function parameters may be bootstrapped to calculate their significance and confidence intervals.

Usage

```
mdcc(chrono, clim, method = "response", start = 4, end = 9, timespan =
NULL, vnames = NULL, sb = TRUE, win.size = 25, win.offset =
1, startlast = TRUE, boot = FALSE, ci = 0.05)
```

Arguments

chrono	data.frame containing a tree-ring chronologies, e.g. as obtained by chron of package dplR.
clim	data.frame with climatic data in monthly resolution, with year, month and climate parameters in columns. All columns except year and month will be recognized as parameters for response or correlation function.
method	string specifying the calculation method. Possible values are "response" and "correlation". Partial strings are ok.
start	integer value to determine the first month to be used as a predictor in the response or correlation function. A negative value denotes a start month from previous year, a positive value denotes a start month from current year.
end	integer value to determine the last month to be used as a predictor in the response or correlation function. A negative value denotes an end month from previous year, a positive value denotes an end month from current year.
timespan	integer vector of length 2 specifying the time interval (in years) to be considered for analysis. Defaults to the maximum possible interval.
vnames	character vector with variable names. defaults to corresponding column names of data.frame clim.
sb	logical flag indicating whether textual status bar should be suppressed. Suppression is recommended for e.g. Sweave files.
win.size	integer giving the window size for each recalculation.
win.offset	integer giving the number of years between each window start.
startlast	logical flag indicating whether the first window should start at the rear end (youngest part of the series) or not.
boot	logical flag indicating whether bootstrap resampling is to be performed.
ci	numerical value to set the test level for significance test (values 0.01, 0.05 and 0.1 are allowed); the confidence intervals are adapted accordingly.

Details

The functions dcc and mdcc clone the functionality of programme DENDROCLIM2002 (Biondi and Waikul, 2004), and will calculate bootstrapped (and non-bootstrapped) moving (mdcc and static (dcc) response and correlation functions in a similar fashion as described in the above mentioned paper.

In case of response function analysis 1000 bootstrap samples are taken from the original distribution and an eigen decomposition of the standardized predictor matrix is performed. Nonrelevant eigenvectors are removed using the PVP criterion (Guiot, 1990), principal component scores are then calculated from the matrices of reduced eigenvectors and standardized climatic predictors. Response coefficients are found via singular value decomposition, and tested for significance using the 95% percentile range method (Dixon, 2001). In case of correlation function analysis, the coefficients are Pearson's correlation coefficients. The same method for significance testing is applied.

Input chronology data can be a data.frame such as produced by function chron of package dplR. It has to be a data.frame with at least one column containing the tree-ring indices, and the corresponding years as rownames.

For climatic input data, there are three possibilities: Firstly, input climatic data can be a `data.frame` or `matrix` consisting of at least 3 rows for years, months and at least one climate parameter in the given order. Secondly, input climatic data can be a single `data.frame` or `matrix` in the style of the original DENDROCLIM2002 input data, i.e. one parameter with 12 months in one row, where the first column represents the year. Or thirdly, input climatic data can be a list of several of the latter described `data.frame` or `matrices`. As an internal format dispatcher checks the format automatically, it is absolutely necessary that in all three cases, only complete years (months 1-12) are provided. It is not possible to mix different formats in one go.

The window for response/correlation function analysis is specified via `start` and `end`, where e.g. -4 means previous April etc.

The window size for moving response and correlation functions is set via `win.size`, and the distance from one window start to the next is set with the parameter `win.offset`. Parameter `startlast` indicates, wether the first window is started from the rear (youngest part) of the series or not.

Bootstrapping (`boot`) is by default disabled to get the results faster.

Value

A `list` containing `data.frames` for coefficients and confidence intervals for each parameter and time window used for the moving functions.

Author(s)

Christian Zang

References

Biondi, F. & Waikul, K. (2004) DENDROCLIM2002: A C++ program for statistical calibration of climate signals in tree-ring chronologies. *Computers & Geosciences* 30:303-311

Dixon, P.M. (2001) Bootstrap resampling. In: El-Shaarawi, A.H., Piegorsch, W.W. (Eds.), *The Encyclopedia of Environmetrics*. Wiley, New York.

Guiot, J. (1991) The boostrapped response function. *Tree-Ring Bulletin* 51:39-41

See Also

`mdcplot` `dcc`

Examples

```
data(muc.clim) # climatic data
data(muc.spruce) # spruce data

# calculate and plot moving response function
dc.mov1 <- mdcc(muc.spruce, muc.clim)
mdcplot(dc.mov1)

# calculate and plot moving correlation function with different window parameters

data(rt.spruce)
```

```
data(rt.temp)
data(rt.prec)

dc.mov2 <- mdcc(rt.spruce, list(rt.temp, rt.prec), vnames = c("temp", "prec"), method = "corr", win.size = 20,
win.offset = 5)
mdcplot(dc.mov2)
```

`mdcplot` *Plotting Function for Moving Response and Correlation Functions*

Description

A simple plotting function for response and correlation functions derived from `mdcc`.

Usage

```
mdcplot(x, rescale = TRUE, ...)
```

Arguments

`x`	`data.frame` with coefficients derived from `mdcc`.
`rescale`	logical: should coefficients be rescaled to use full color gradient?
`...`	additional arguments passed to plot(...)

Details

Rescaling of coefficients results in more contrast for color palette. For comparison of absolute values (between different plots), this should be set to FALSE. Rescaling is done seperately for positive and negative values.

Previous to bootRes version 1.2.2, `mdcc` would return a single `data.frame` of coefficients, regardless if bootstrapping was enabled or not. In more recent versions, a `list` of `data.frames` is returned, containing members for coefficients and confidence intervals. The type of `x` is checked internally, so there is no change in the interface of `mdcplot`.

Value

None. Invoked for side effect (plot).

Author(s)

Christian Zang

See Also

`mdcc`

Examples

```
data(muc.clim)
data(muc.spruce)

# calculate and plot bootstrapped correlation function
mdc <- mdcc(muc.spruce, muc.clim, method = "corr")
mdcplot(mdc)
```

`muc.clim` *Monthly Mean Temperature and Total Precipitation for Forstenrieder Park, Munich*

Description

This dataset gives the monthly mean temperature and total precipitation at Forstenrieder Park, Munich, Bavaria, Germany.

Usage

```
muc.clim
```

Format

A `data.frame` containing four columns with year, month, temperature and precipitation.

References

Kagerer, K. (2009) Wachstum von Fichte, Kiefer und Eiche in Abhaengigkeit von Klima und Kronenklasse im Forstenrieder Park, Muenchen. Diploma-Thesis, University of Applied Sciences Weihenstephan.

`muc.fake` *Modeled Tree-Ring Chronology of a Spruce Population near Munich*

Description

This dataset gives the modelled tree-ring widths for *Picea abies* at Forstenrieder Park, Munich, Bavaria, Germany. Tree growth was modeled as a response of low temperatures in previous and current July and August, high temperatures in current February and March, and high precipitation amounts in current July and August.

Usage

```
muc.fake
```

Format

A data.frame containing tree-ring indices with respective years as rownames. in rows.

References

Kagerer, K. (2009) Wachstum von Fichte, Kiefer und Eiche in Abhaengigkeit von Klima und Kronenklasse im Forstenrieder Park, Muenchen. Diploma-Thesis, University of Applied Sciences Weihenstephan.

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muc.spruce *Tree-Ring Chronology of a Spruce Population near Munich*

Description

This dataset gives the tree-ring indices for *Picea abies* at Forstenrieder Park, Munich, Bavaria, Germany. The chronology represents 20 cores from 10 trees. The series were read in using read.rwl from package dplR, detrended using a 60a spline with 50% frequency cutoff (function detrend), and averaged to a chronology using a robust mean chron.

Usage

```
muc.spruce
```

Format

A data.frame containing tree-ring indices and replication depth with respective years as rownames.

References

Zang, C., Pretzsch, H., Rothe, A., 2011. Size-dependent responses to summer drought in Scots pine, Norway spruce and common oak. Trees - Structure and Function. URL http://www.springerlink.com/index/10.1007/s00468-011-0617-z

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rt.prec *Monthly Precipitation Sums for Rothenburg ob der Tauber, Germany*

Description

This dataset gives the monthly precipitation sum at Rothenburg ob der Tauber, Bavaria, Germany in a decadal (DENDROCLIM2002-style) format)

Usage

```
rt.prec
```

Format

A `data.frame` containing thirteen columns with year and twelve months of precipitation data in degree Celsius.

References

Zang, C. (2010) Growth reaction of precerate forest trees to summer drought – a multispecies tree-ring network approach. Ph.D. Thesis, Technische Universitaet Muenchen, 164 pp.

`rt.spruce` *Tree-Ring Chronology of a Spruce Population at Rothenburg ob der Tauber*

Description

This dataset gives the tree-ring indices for *Picea abies* at Rothenburg ob der Tauber, Bavaria, Germany. The chronology represents 20 cores from 10 trees. The series were read in using `read.rwl` from package `dplR`, detrended using a 60a spline with 50% frequency cutoff (function `detrend`), and averaged to a chronology using a robust mean `chron`.

Usage

```
rt.spruce
```

Format

A `data.frame` containing tree-ring indices and replication depth with respective years as `rownames`.

References

Zang, C., Rothe, A., Weis, W., Pretzsch, H., 2011. Zur Baumarteneignung bei Klimawandel: Ableitung der Trockenstress-Anf\"alligkeit wichtiger Waldbaumarten aus Jahrringbreiten. Allgemeine Forst- und Jagdzeitung 182, 98-112.

`rt.temp` *Monthly Mean Temperature for Rothenburg ob der Tauber, Germany*

Description

This dataset gives the monthly mean temperature at Rothenburg ob der Tauber, Bavaria, Germany in a decadal (DENDROCLIM2002-style) format)

Usage

```
rt.temp
```

Format

A `data.frame` containing thirteen columns with year and twelve months of temperature data in degree Celsius.

References

Zang, C. (2010) Growth reaction of temperate forest trees to summer drought – a multispecies tree-ring network approach. Ph.D. Thesis, Technische Universitaet Muenchen, 164 pp.

Index