Package 'climtrends'

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Title Statistical Methods for Climate Sciences

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Description Absolute homogeneity tests SNHT absolute 1-breaks, 1-break, SD different from 1, 2-breaks, Buishand, Pettitt, von Neumann ratio and ratio-rank, Worsley, and Craddock, Relative homogeneity tests SNHT absolute 1-breaks, 1-break SD different from 1, 2-breaks, Peterson and Easterling, and Vincent, Differences in scale between two groups Siegel–Tukey, Create reference time series mean, weights/correlation, finding outliers Grubbs, ESD, MAD, Tietjen Moore, Hampel, etc.

License GPL (>= 3)

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LazyData yes

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NeedsCompilation no

R topics documented:

AdjHomogenization *Homogenization adjustment within a certain window*

Description

AdjHomogenization returns the value for homogenization adjustment within a certain window.

Usage

```
AdjHomogenization(dataYearSeries=NA,yearShift=NA,nYears=20, diffFlag=TRUE)
```

Arguments

dataYearSeries	dataframe with climate data
yearShift	year when the shift occured
nYears	window of years to adjust
diffFlag	logical TRUE=difference, FALSE=ratio

Value

homgenized data.

Author(s)

Jose Gama

AllfilesIEObyPathPattern *Read multiple IEO files*

Description

AllfilesIEObyPathPattern reads multiple daily values file from IEO (Instituto Español de Oceanografia, Spain).

Usage

```
AllfilesIEObyPathPattern(mypath, mypattern)
```

Arguments

mypath	Path to search for files
mypattern	Pattern to search for file names

Value

A list with the read data.

Author(s)

Jose Gama

`AllReadUSGS2timeseries`
Read multiple USGS files

Description

`AllReadUSGS2timeseries` reads multiple USGS discharge files.

Usage

```
AllReadUSGS2timeseries()
```

Arguments

none

Value

A list with the read data.

Author(s)

Jose Gama

`annual.precipitation.totals.Madison`
Annual precipitation totals in inches Madison (Wisconsin)

Description

`annual.precipitation.totals.Madison` contains the annual precipitation totals in inches from Madison (Wisconsin) - courtesy of Madison Climate Page/State Climatology Homepage.

Usage

```
annual.precipitation.totals.Madison
```

Format

This data frame contains 2 columns (year and precipitationInches) and 135 rows of data.

Author(s)

Jose Gama

Source

Madison Climate Page/State Climatology Homepage Annual precipitation totals in inches http://www.aos.wisc.edu/~sco/clim-history/stations/msn/msn-pcpn.html

References

Madison Climate Page/State Climatology Homepage Annual precipitation totals in inches http://www.aos.wisc.edu/~sco/clim-history/stations/msn/msn-pcpn.html

Examples

```
data(annual.precipitation.totals.Madison)
str(annual.precipitation.totals.Madison)
```

BSXFUN *Apply a function to each element of 2 arrays with singleton expansion enabled*

Description

BSXFUN applies a function to each element of 2 arrays with singleton expansion enabled, clone of MATLAB's BSXFUN

Usage

```
BSXFUN(op, x, y)
```

Arguments

op	binary function to apply to arrays x and y
x	array of numeric or boolean values
y	array of numeric or boolean values

Value

array of numeric or boolean values with the result of function op applied to x and y

Author(s)

Jose Gama

Source

Douglas M. Schwarz, 2006 Generalized Array Operations http://www.mathworks.com/matlabcentral/fileexchange/10333-generalized-array-operations/content/genop.m

References

Douglas M. Schwarz, 2006 Generalized Array Operations http://www.mathworks.com/matlabcentral/fileexchange/10333-generalized-array-operations/content/genop.m

Examples

```
#example 1
x<-matrix(c(17,24,1,8,15,23,5,7,14,16,4,6,13,20,22,10,12,19,21,3,11,18,25,2,9),
5,5,byrow=TRUE)
y<-matrix(13,1,5)
op<-'+'
BSXFUN(op,x,y)

#example 2
d1<-c(4,3,1,2)
x = array(runif(prod(d1)),d1)
d2<-c(4,1,5,2)
y = array(runif(prod(d2)),d2)
op<-'*'
BSXFUN(op,x,y)

#example 3
d1<-c(1,2,5,6,3)
x<-array(1:prod(d1),d1)
d2<-c(1,2,5,1,3,4)
y<-array(1:prod(d2),d2)
op<-'+'
BSXFUN(op,x,y)
```

Buishand.Critical.Values

Critical values for the Buishand test

Description

`Buishand.Critical.Values` contains the critical values for the Buishand test.

Usage

```
Buishand.Critical.Values
```

Format

This data frame contains 6 columns (Q90 and 7 rows (n=10, 20, 30, 40, 50, 100 and Inf) of data.

Author(s)

Jose Gama

Source

Buishand TA., 1981 The analysis of homogeneity of long-term rainfall records in the Netherlands. KNMI Scientific Report WR 81-7, De Bilt, The Netherlands.

References

Buishand TA., 1981 The analysis of homogeneity of long-term rainfall records in the Netherlands. KNMI Scientific Report WR 81-7, De Bilt, The Netherlands.

Examples

```
data(Buishand.Critical.Values)
Buishand.Critical.Values
```

BuishandRangeTest *Buishand range absolute homogeneity test*

Description

`BuishandRangeTest` returns the result of the Buishand range test applied to a time series.

Usage

```
BuishandRangeTest(dataSeries)
```

Arguments

`dataSeries`	time series of climate data

Value

The result of the Buishand range test.

Author(s)

Jose Gama

Source

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

References

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

Examples

```
# Buishand range test for Turin 1961-2003
BuishandTurin<- BuishandRangeTest(yearly.average.temperature.Turin.Milan[,2])

# Buishand range test for Milan 1961-2003
BuishandMilan<- BuishandRangeTest(yearly.average.temperature.Turin.Milan[,3])

plot(1961:2003,BuishandTurin,type='l',col='cyan',ylim=c(-2.5,0.5),
main='Buishand range test 1961-2003',xlab='Years',ylab='Buishand value')
par(new=TRUE)
plot(1961:2003,BuishandMilan,type='l',col='magenta',ylim=c(-2.5,0.5),xlab='',ylab='')
legend("top",c('Turin','Milan'),text.col=c('cyan','magenta'))
```

CompleteMissingValuesDailyMean

complete missing values on a time series of daily values (mean)

Description

CompleteMissingValuesDailyMean complete missing values on a time series of daily values by using the average of 1 or more days before or after.

Usage

```
CompleteMissingValuesDailyMean(dataSeries, windowBefore=1,windowAfter=1,
 missingValue=-9999)
```

Arguments

dataSeries	dataframe with climate data
windowBefore	number of days before the day with missing data
windowAfter	number of days after the day with missing data
missingValue	value representing missing data

Value

Time series.

Author(s)

Jose Gama

`CraddockTest` *Craddock test*

Description

`CraddockTest` returns the result of the Craddock test applied to a time series.

Usage

```
CraddockTest(yearDF, valcol1, valcol2)
```

Arguments

`yearDF`	dataframe with climate data
`valcol1`	column with values
`valcol2`	column with values

Value

The result of the Craddock test.

Author(s)

Jose Gama

Source

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

References

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

Examples

```
demo(demoCraddockTest)
```

CreateReferenceSeriesFromFilesMean
Create a reference series (averaging)

Description

CreateReferenceSeriesFromFilesMean creates a reference series from two or more series, using averages.

Usage

```
CreateReferenceSeriesFromFilesMean(vFiles,commonPeriod=NA,refSeriesFile=NA,
wholePeriod=FALSE,deviationsFlag=FALSE)
```

Arguments

vFiles	vector with the file names of the time series
commonPeriod	user defined common period for the resulting reference series, by default the common period to all series
refSeriesFile	reference series file name
wholePeriod	logical, common period=TRUE
deviationsFlag	logical, raw data=TRUE, deviations=FALSE

Value

reference series or none (if the user chose a reference series file name).

Author(s)

Jose Gama

Source

Stepanek, P. 2008 AnClim - software for time series analysis Dept. of Geography, Fac. of Natural Sciences http://www.climahom.eu/AnClim.html

References

Stepanek, P. 2008 AnClim - software for time series analysis Dept. of Geography, Fac. of Natural Sciences http://www.climahom.eu/AnClim.html

Examples

```
# c_As00_o.txt, c_Hori2.txt and c_Kada2.txt are from AnClim freeware distribution
setwd(system.file('extdata/', package='climtrends'))
vFiles=c('c_As00_o.txt','c_Hori2.txt','c_Kada2.txt')
refSeries=CreateReferenceSeriesFromFilesMean(vFiles)
```

`CreateReferenceSeriesFromFilesMeanCorrelations` *Create a reference series (averaging weights/correlations)*

Description

`CreateReferenceSeriesFromFilesMeanCorrelations` creates a reference series from two or more series, using weighted averages (correlations). `CreateReferenceSeriesFromFilesMeanCorrelationsTwoseries` is for two series only, using a simpler and faster method.

Usage

```
CreateReferenceSeriesFromFilesMeanCorrelations(vFiles,commonPeriod=NA,
refSeriesFile=NA,wholePeriod=FALSE,useDiff=TRUE,retInfo=FALSE)
```

Arguments

`vFiles`	vector with the file names of the time series
`commonPeriod`	user defined common period for the resulting reference series, by default the common period to all series
`refSeriesFile`	reference series file name
`wholePeriod`	logical, common period=TRUE
`useDiff`	logical, raw differences=TRUE, ratios=FALSE
`retInfo`	logical, return reference series from function=TRUE

Value

reference series or none (if the user chose a reference series file name).

Author(s)

Jose Gama

Source

Stepanek, P. 2008 AnClim - software for time series analysis Dept. of Geography, Fac. of Natural Sciences http://www.climahom.eu/AnClim.html

References

Stepanek, P. 2008 AnClim - software for time series analysis Dept. of Geography, Fac. of Natural Sciences http://www.climahom.eu/AnClim.html

Examples

```
# c_As00_o.txt, c_Hori2.txt and c_Kada2.txt are from AnClim freeware distribution
setwd(system.file('extdata/', package='climtrends'))
vFiles=c('c_As00_o.txt','c_Hori2.txt','c_Kada2.txt')
refSeries=CreateReferenceSeriesFromFilesMeanCorrelations(vFiles,retInfo=TRUE)
```

Cumulative.Deviations.Test.Critical.Values

Critical values for Worsley's likelihood ratio test

Description

`Cumulative.Deviations.Test.Critical.Values` contains the critical values for the Cumulative Deviations test.

Usage

```
Cumulative.Deviations.Test.Critical.Values
```

Format

This data frame contains 6 columns (Q90 and 7 rows (n=10, 20, 30, 40, 50, 100 and Inf) of data.

Author(s)

Jose Gama

Source

Worsley, K.J., 1979 On the likelihood ratio test for a shift in location of normal populations. J. Am. Stat. Assoc., 74: 365–367.

References

Worsley, K.J., 1979 On the likelihood ratio test for a shift in location of normal populations. J. Am. Stat. Assoc., 74: 365–367.

Examples

```
data(Cumulative.Deviations.Test.Critical.Values)
Cumulative.Deviations.Test.Critical.Values
```

`CumulativeDeviations` *cumulative deviations test (parametric test for step jump in mean)*

Description

`CumulativeDeviations` returns the result (Q) of the cumulative deviations test (parametric test for step jump in mean) applied to a time series. `CumulativeDeviationsQR` return Q, R and abs(Q)/sqrt(N).

Usage

```
CumulativeDeviations(dataSeries)
```

Arguments

`dataSeries`	vector with climate data

Value

The result of the cumulative deviations test.

Author(s)

Jose Gama

Source

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

References

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

Examples

```
# cumulative deviations for Turin 1961-2003
cdTurin<- CumulativeDeviations(yearly.average.temperature.Turin.Milan[,2])

# cumulative deviations for Milan 1961-2003
cdMilan<- CumulativeDeviations(yearly.average.temperature.Turin.Milan[,3])

plot(1961:2003,cdTurin,type='l',col='cyan',ylim=c(0,15),
main='Cumulative deviations 1961-2003',xlab='Years',ylab='C.D.')
par(new=TRUE)
plot(1961:2003,cdMilan,type='l',col='magenta',ylim=c(0,15),xlab='',ylab='')
legend("top",c('Turin','Milan'),text.col=c('cyan','magenta'))
```

DailyClimatologyFromDailyData

Daily climatology

Description

`DailyClimatologyFromDailyData` returns the daily climatology (long-term average, for each day, of a given variable).

Usage

```
DailyClimatologyFromDailyData(dataSeries,fromYear=1961,toYear=1990)
```

Arguments

`dataSeries`	time series of climate data
`fromYear`	start of the long-term average
`toYear`	end of the long-term average

Value

Daily climatology.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville <- ReadGHCNymd('xgdcnCA008201000.dat')
dailyCollegevilleDailyClimatology <- DailyClimatologyFromDailyData(dailyCollegeville)
```

DistributionFreeCUSUM *Distribution Free CUSUM (non-parametric test for step jump in mean)*

Description

DistributionFreeCUSUM returns the result of the Distribution Free CUSUM (non-parametric test for step jump in mean) applied to a time series.

Usage

```
DistributionFreeCUSUM(dataSeries)
```

Arguments

dataSeries	vector with climate data

Value

The result of the Distribution Free CUSUM test.

Author(s)

Jose Gama

Source

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

References

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

Examples

```
# Distribution Free CUSUM for Turin 1961-2003
testTurin<- DistributionFreeCUSUM(yearly.average.temperature.Turin.Milan[,2])

# Distribution Free CUSUM for Milan 1961-2003
testMilan<- DistributionFreeCUSUM(yearly.average.temperature.Turin.Milan[,3])
```

ESDstatistic *ESD statistic*

Description

`ESDstatistic` returns the ESD statistic.

Usage

```
ESDstatistic(dataSeries)
```

Arguments

`dataSeries`	time series of climate data

Value

The ESD statistic.

Author(s)

Jose Gama

Source

NIST/SEMATECH e-Handbook of Statistical Methods, 2013 http://www.itl.nist.gov/div898/handbook/

References

NIST/SEMATECH e-Handbook of Statistical Methods, 2013 http://www.itl.nist.gov/div898/handbook/

Examples

```
# ESD statistic for Turin 1961-2003
testTurin<- ESDstatistic(yearly.average.temperature.Turin.Milan[,2])
```

FillDailyGapsWithSomeValue *fill missing days with some value*

Description

FillDailyGapsWithSomeValue fills (literally) missing days with date+some value.

Usage

```
FillDailyGapsWithSomeValue(dataYearSeries,FromDate,ToDate, missingValue=-9999)
```

Arguments

dataYearSeries	dataframe with climate data
FromDate	starting date
ToDate	ending date
missingValue	value representing missing data

Value

complete time series.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville <- ReadGHCNymd('xgdcnCA008201000.dat')
daylyCollegeville2<-FillDailyGapsWithSomeValue(dailyCollegeville,
'1916-06-01','2010-11-30', missingValue=NA)
str(dailyCollegeville)
str(daylyCollegeville2)
```

FillYearlyGapsWithSomeValue
fill missing days with some value

Description

FillYearlyGapsWithSomeValue fills (literally) missing years with date+some value.

Usage

```
FillYearlyGapsWithSomeValue(dataYearSeries,FromYear=min(dataYearSeries[,1]),
ToYear=max(dataYearSeries[,1]), missingValue=-9999)
```

Arguments

dataYearSeries	dataframe with climate data
FromYear	starting year
ToYear	ending year
missingValue	value representing missing data

Value

complete time series.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville=ReadGHCNymd('xgdcnCA008201000.dat')
yearlyCollegeville=YearFuncFromDay(dailyCollegeville)
colnames(yearlyCollegeville) <- c('year','temperature')
yearlyCollegeville<-ValuesBetween2years(yearlyCollegeville,1918,1993)
yearlyCollegeville<-FillYearlyGapsWithSomeValue(yearlyCollegeville, missingValue=NA)
plot(yearlyCollegeville,type='l')
```

FindCommonPeriod *Find the common period between several time series*

Description

FindCommonPeriod returns the common period between several time series.

Usage

```
FindCommonPeriod(vFiles, returnMaxMin=FALSE)
```

Arguments

vFiles	vector with file names of time series
returnMaxMin	logical, TRUE=the function returns the max and min from all the series

Value

none or a vector (max, min).

Author(s)

Jose Gama

FindOutliersESDtest *Find outliers based on the ESD test*

Description

FindOutliersESDtest returns the position of the values outside the allowed range by a criteria based on the ESD test.

Usage

```
FindOutliersESDtest(dataSeries,k=10,alpha=0.05)
```

Arguments

dataSeries	time series of climate data
k	number of outliers
alpha	significance level

Value

Vector with the positions of the outliers.

Author(s)

Jose Gama

Source

NIST/SEMATECH e-Handbook of Statistical Methods, 2013 http://www.itl.nist.gov/div898/handbook/

References

NIST/SEMATECH e-Handbook of Statistical Methods, 2013 http://www.itl.nist.gov/div898/handbook/

Examples

```
y = c(-0.25, 0.68, 0.94, 1.15, 1.20, 1.26, 1.26,
       1.34, 1.38, 1.43, 1.49, 1.49, 1.55, 1.56,
       1.58, 1.65, 1.69, 1.70, 1.76, 1.77, 1.81,
       1.91, 1.94, 1.96, 1.99, 2.06, 2.09, 2.10,
       2.14, 2.15, 2.23, 2.24, 2.26, 2.35, 2.37,
       2.40, 2.47, 2.54, 2.62, 2.64, 2.90, 2.92,
       2.92, 2.93, 3.21, 3.26, 3.30, 3.59, 3.68,
       4.30, 4.64, 5.34, 5.42, 6.01)
FindOutliersESDtest(y)
```

FindOutliersGrubbsTwosided

Find outliers based on the Grubbs test

Description

FindOutliersGrubbsTwosided returns the position of the values outside the allowed range by a criteria based on the Grubbs test (two-sided, one-sided max and one-sided min).

Usage

```
FindOutliersGrubbsTwosided(dataSeries,alpha=0.05, iterative=TRUE)
```

Arguments

dataSeries	time series of climate data
alpha	significance level
iterative	logical, TRUE=iterative, FALSE=first value only

Value

Vector with the positions of the outliers.

Author(s)

Jose Gama

Source

NIST/SEMATECH e-Handbook of Statistical Methods, 2013 http://www.itl.nist.gov/div898/handbook/

References

NIST/SEMATECH e-Handbook of Statistical Methods, 2013 http://www.itl.nist.gov/div898/handbook/

Examples

```
# Input data from the Tietjen and Moore paper.
y = c(199.31,199.53,200.19,200.82,201.92,201.95,202.18,245.57)
FindOutliersGrubbsTwosided(y, iterative=FALSE)
FindOutliersGrubbsTwosided(y)
```

FindOutliersHampel *Find outliers based on quantiles*

Description

FindOutliersHampel returns the position of the values outside the allowed range by the Hampel method.

Usage

```
FindOutliersHampel(X, Y, DX=NA, Th=NA, hampelAdaptive=FALSE,Threshold=NA)
```

Arguments

X	vector with data
Y	vector with data, Gaussian distributed
DX	half width of the filter window
Th	threshold value used in the equation |Y - Y0| > T*S0
hampelAdaptive	logical, TRUE=experimental adaptive Hampel filter
Threshold	adaptive threshold

Value

Vector with the positions of the outliers.

Author(s)

Jose Gama

Source

Pearson RK, 2012 Mining Imperfect Data: Dealing with Contamination and Incomplete Records urlhttp://exploringdatablog.blogspot.com/2012/01/moving-window-filters-and-pracma.html

Michael Lindholm Nielsen, 2012 urlhttp://www.mathworks.com/matlabcentral/fileexchange/34795-outlier-detection-and-removal–hampel-

References

Pearson RK, 2012 Mining Imperfect Data: Dealing with Contamination and Incomplete Records urlhttp://exploringdatablog.blogspot.com/2012/01/moving-window-filters-and-pracma.html

Michael Lindholm Nielsen, 2012 urlhttp://www.mathworks.com/matlabcentral/fileexchange/34795-outlier-detection-and-removal–hampel-

Examples

```
X <- 1:1000 # Pseudo Time
Y <- 5000 + rnorm(1000) # Pseudo Data
Outliers <- sample(1:1000, 10, replace =FALSE) # Index of Outliers
Y[Outliers] <- Y[Outliers] + sample(1:1000, 10, replace =FALSE) # Pseudo Outliers
tmp <- FindOutliersHampel(X, Y)
```

FindOutliersMAD *Find outliers based on the absolute deviation around the median*

Description

FindOutliersMAD returns the position of the values outside the allowed range by a criteria based on the the absolute deviation around the median (MAD), median-coef*MAD<x<median+coef*MAD.

Usage

```
FindOutliersMAD(dataSeries,coef=3)
```

Arguments

dataSeries	time series of climate data
coef	coefficient, 3=very conservative, 2.5=moderately conservative 2=poorly conservative.

Value

Vector with the positions of the outliers.

Author(s)

Jose Gama

Source

Leys C, Ley C, Klein O, Bernard P, Licata L, 2013 Detecting outliers: Do not use standard deviation around the mean, use absolute deviation around the median Journal of Experimental Social Psychology volume 49, number 4 urlhttp://www.sciencedirect.com/science/article/pii/S0022103113000668

References

Leys C, Ley C, Klein O, Bernard P, Licata L, 2013 Detecting outliers: Do not use standard deviation around the mean, use absolute deviation around the median Journal of Experimental Social Psychology volume 49, number 4 urlhttp://www.sciencedirect.com/science/article/pii/S0022103113000668

Examples

```
y = c(1, 3, 3, 6, 8, 10, 10, 1000)
outlierMAD <- FindOutliersMAD(y)
y[outlierMAD]
```

FindOutliersQuant *Find outliers based on quantiles*

Description

`FindOutliersQuant` returns the position of the values outside the allowed range by a criteria based on quantiles, q25-coef*(q75-q25)<x<q75+coef*(q75-q25).

Usage

```
FindOutliersQuant(dataSeries,coef=1.5)
```

Arguments

`dataSeries`	time series of climate data
`coef`	coefficient, 2=outliers, 3=extremes.

Value

Vector with the positions of the outliers.

Author(s)

Jose Gama

Source

Stepanek, P. 2008 AnClim - software for time series analysis Dept. of Geography, Fac. of Natural Sciences http://www.climahom.eu/AnClim.html

References

Stepanek, P. 2008 AnClim - software for time series analysis Dept. of Geography, Fac. of Natural Sciences http://www.climahom.eu/AnClim.html

Examples

```
y = c(1, 3, 3, 6, 8, 10, 10, 1000)
FindOutliersQuant(y)
```

FindOutliersSD *Find outliers based on quantiles*

Description

FindOutliersSD returns the position of the values outside the allowed range by a criteria based on the standard deviation, mean-coef*sd<x<mean+coef*sd based on the three-sigma rule.

Usage

```
FindOutliersSD(dataSeries,coef=3)
```

Arguments

dataSeries	time series of climate data
coef	coefficient, 1=68

Value

Vector with the positions of the outliers.

Author(s)

Jose Gama

Source

Leys C, Ley C, Klein O, Bernard P, Licata L, 2013 Detecting outliers: Do not use standard deviation around the mean, use absolute deviation around the median Journal of Experimental Social Psychology volume 49, number 4 urlhttp://www.sciencedirect.com/science/article/pii/S0022103113000668

References

Leys C, Ley C, Klein O, Bernard P, Licata L, 2013 Detecting outliers: Do not use standard deviation around the mean, use absolute deviation around the median Journal of Experimental Social Psychology volume 49, number 4 urlhttp://www.sciencedirect.com/science/article/pii/S0022103113000668

Examples

```
y = c(1, 3, 3, 6, 8, 10, 10, 1000)
FindOutliersSD(y,2)
```

`FindOutliersTietjenMooreTest`

Find outliers based on the Tietjen Moore test

Description

`FindOutliersTietjenMooreTest` returns the position of the values outside the allowed range by a criteria based on the Tietjen Moore test.

Usage

```
FindOutliersTietjenMooreTest(dataSeries,k,alpha=0.05)
```

Arguments

`dataSeries`	time series of climate data
`k`	number of outliers
`alpha`	significance level

Value

Vector with the positions of the outliers.

Author(s)

Jose Gama

Source

NIST/SEMATECH e-Handbook of Statistical Methods, 2013 http://www.itl.nist.gov/div898/handbook/

References

NIST/SEMATECH e-Handbook of Statistical Methods, 2013 http://www.itl.nist.gov/div898/handbook/

Examples

```
x <- c(-1.40, -0.44, -0.30, -0.24, -0.22, -0.13, -0.05, 0.06, 0.10, 0.18,
 0.20, 0.39, 0.48, 0.63, 1.01)
FindOutliersTietjenMooreTest(x, 2)
```

`FindOutliersTrimmedMeans` *Find outliers based on trimmed means*

Description

`FindOutliersTrimmedMeans` returns the position of the values outside the allowed range by a criteria based on trimmed means.

Usage

```
FindOutliersTrimmedMeans(dataSeries, percentTrim=0.1, coef=3)
```

Arguments

`dataSeries`	time series of climate data
`percentTrim`	percentage to trim
`coef`	coefficient

Value

Vector with the positions of the outliers.

Author(s)

Jose Gama

Examples

```
FindOutliersTrimmedMeans(c(2, 4, 6, 7, 11, 21, 81, 90, 105, 121))
```

FindOutliersZscore *Find outliers based on the z-score*

Description

FindOutliersZscore returns the position of the values outside the allowed range by a criteria based on the z-score, abs(Z)>coef. FindOutliersModifiedZscore uses the modified z-score.

Usage

```
FindOutliersZscore(dataSeries, coef=2.5)
```

Arguments

dataSeries	time series of climate data
coef	coefficient

Value

Vector with the positions of the outliers.

Author(s)

Jose Gama

Examples

```
FindOutliersZscore(c(2, 4, 6, 7, 11, 21, 81, 90, 105, 121))
```

FirstMonthOfSeason *Get the first/last month of a season*

Description

FirstMonthOfSeason returns the first month number for a given season 1 12, 2 3, 3 6, 4 9. LastMonthOfSeason returns the last month number for a given season 1 2, 2 5, 3 8, 4 11.

Usage

```
FirstMonthOfSeason(intSeason)
```

Arguments

intSeason	season

Value

first/last month of a season.

Author(s)

Jose Gama

Examples

```
FirstMonthOfSeason(1) # Winter
FirstMonthOfSeason(2) # Spring
FirstMonthOfSeason(3) # Summer
FirstMonthOfSeason(4) # Fall
```

GetInfoHomogenization *Useful info from an homogenization test*

Description

GetInfoHomogenization calculates the SNHT or other method of homogenization and returns useful info such as the year of change, To value, adjust value and more.

Usage

```
GetInfoHomogenization(dataYearSeries=NA,refYearSeries=NA,nYears=20,
diffFlag=TRUE,returnData=FALSE, homogenization=SNHTabsolute,
levelSignificance=c(99,95),criticalValues=climtrends::SNHT.Critical.Values)
```

Arguments

dataYearSeries	dataframe with climate data
refYearSeries	dataframe with climate data (reference)
nYears	window of years to adjust
diffFlag	logical TRUE=difference, FALSE=ratio
returnData	logical TRUE=return the homogenization test data
homogenization	homogenization test
levelSignificance	level of significance
criticalValues	critical values for the homogenization test

Value

number of wet days.

Author(s)

Jose Gama

GetNDP *Read data from a Numeric Data Package (NDP) file from GCMD*

Description

GetNDP returns one climate variable from one NDP file read into a data.frame from NASA's Global Change Master Directory (GCMD) datasets.

Usage

```
GetNDP(ndpDat, climVar)
```

Arguments

ndpDat	File name
climVar	Cimate variable

Value

A data.frame with the read data.

Author(s)

Jose Gama

GetShiftValue *Get peak value and its sign*

Description

GetShiftValue returns the peak value and NegCurve returns the sign of the test values).

Usage

```
GetShiftValue(values)
NegCurve(values)
```

Arguments

values	test values

Value

peak value or its sign.

Author(s)

Jose Gama

Examples

```
GetShiftValue(c(1,2,3,4,3,2,1))
NegCurve(c(1,2,3,4,3,2,1))
```

`IsLeapYear` *Determine if a year is a leap year*

Description

`IsLeapYear` returns TRUE for a leap year.

Usage

```
IsLeapYear(intYear)
```

Arguments

`intYear`	year

Value

logical, TRUE = leap year.

Author(s)

Jose Gama

Examples

```
IsLeapYear(2010)
IsLeapYear(2011)
IsLeapYear(2012)
IsLeapYear(2013)
```

LastDayOfTheMonth *Get the last day of a month*

Description

LastDayOfTheMonth returns the last day of a month, considering leap years too.

Usage

```
LastDayOfTheMonth(intMonth,intYear)
```

Arguments

intMonth	month 1-12
intYear	year

Value

last day of a month.

Author(s)

Jose Gama

Examples

```
LastDayOfTheMonth(2,2010)
LastDayOfTheMonth(2,2011)
LastDayOfTheMonth(2,2012)
LastDayOfTheMonth(2,2013)
```

LevelSignifMarks *Use symbols to represent the level of significance*

Description

LevelSignifMarks returns a certain number of marks depending on the level of significance achieved by the value statistic.

Usage

```
LevelSignifMarks(dataSeries=NA, levelSignificance=c(99,95), userDefSymbol='<')
```

Arguments

dataSeries	time series of climate data
levelSignificance	level of significance
userDefSymbol	symbol used to represent the level of significance

Value

symbols representing the level of significance.

Author(s)

Jose Gama

ListContinuousDays *List the days with continuous data*

Description

ListContinuousDays lists the days with continuous data from a time series with daily data.

Usage

```
ListContinuousDays(dataSeries)
```

Arguments

dataSeries	dataframe with climate data

Value

data.frame with the days with continuous data.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville <- ReadGHCNymd('xgdcnCA008201000.dat')
ListContinuousDays(dailyCollegeville)
```

`ListHomogStats` *List with the years of a probable shift and other info*

Description

`ListHomogStats` applies an homogenization method and returns a list with the years of a probable shift and other useful results. Equivalent to the "Homogenization Overview" in AnClim.

Usage

```
ListHomogStats(dataYearSeries=NA,refYearSeries=NA,diffFlag=TRUE,
homogenization=SNHTabsolute,levelSignificance=c(99,95),
criticalValues=climtrends::SNHT.Critical.Values,userDefSymbol='<',nYears=20)
```

Arguments

`dataYearSeries`	dataframe with climate data
`refYearSeries`	dataframe with climate data (reference)
`diffFlag`	logical TRUE=difference, FALSE=ratio
`homogenization`	homogenization test
`levelSignificance`	level of significance
`criticalValues`	critical values for the homogenization test
`userDefSymbol`	symbol used to represent the level of significance
`nYears`	window of years to adjust

Value

none.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville <- ReadGHCNymd('xgdcnCA008201000.dat')
ListHomogStats(dailyCollegeville)
```

ListHomogTZ *Useful info from an homogenization test*

Description

ListHomogTZ calculates the SNHT or other method of homogenization and returns useful info on the screen, such as the year of change, To value, adjust value and more.

Usage

```
ListHomogTZ(dataYearSeries=NA,refYearSeries=NA,diffFlag=TRUE,
homogenization=SNHTabsolute, testName='')
```

Arguments

dataYearSeries	dataframe with climate data
refYearSeries	dataframe with climate data (reference)
diffFlag	logical TRUE=difference, FALSE=ratio
homogenization	homogenization test
testName	optional title for the report

Value

none.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville <- ReadGHCNymd('xgdcnCA008201000.dat')
x <- ListHomogTZ(dailyCollegeville)
```

`MedianCrossingTest` *Median Crossing (non-parametric test for randomness)*

Description

`MedianCrossingTest` returns the result of the Median Crossing (non-parametric test for randomness) applied to a time series.

Usage

```
MedianCrossingTest(dataSeries)
```

Arguments

`dataSeries`	vector with climate data

Value

The result of the Median Crossing test.

Author(s)

Jose Gama

Source

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

References

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

Examples

```
x=c(681,3661,8625,2475,573,2794,10190,5143,4139,8945,7295,19883,12119,8772,
8848,16309,16254,2303,7671,3985,
13742,5333,4859,12381,12137,6075,4669,378,7507,3891,13046,12954,2445,14759,
20200,16331,6922,6739,11629,
7351,2445,9960,10,11786,10214,11216,8393,10005,6896,11632)
R <- MedianCrossingTest(x)
plot(1941:1989,R,type='b',pch=15)
```

MonthlyAnomaliesFromDailyData
Monthly anomalies

Description

MonthlyAnomaliesFromDailyData returns the monthly anomalies (observed values minus climatology) for a certain year.

Usage

```
MonthlyAnomaliesFromDailyData(dataSeries, yearAnomalies = NA, fromYear=1961,
 toYear=1990)
```

Arguments

dataSeries	time series of climate data
yearAnomalies	year of observed values
fromYear	start of the long-term average for the climatology
toYear	end of the long-term average for the climatology

Value

Monthly anomalies.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville <- ReadGHCNymd('xgdcnCA008201000.dat')
MonthlyAnomaliesFromDailyData(dailyCollegeville, 1960)
```

MonthlyClimatologyFromDailyData *Monthly climatology*

Description

MonthlyClimatologyFromDailyData returns the monthly climatology (long-term average, for each month, of a given variable).

Usage

```
MonthlyClimatologyFromDailyData(dataSeries,fromYear=1961,toYear=1990)
```

Arguments

dataSeries	time series of climate data
fromYear	start of the long-term average
toYear	end of the long-term average

Value

Monthly climatology.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville <- ReadGHCNymd('xgdcnCA008201000.dat')
MonthlyClimatologyFromDailyData(dailyCollegeville)
```

MonthlyFuncFromDay *Monthly values converted from daily values*

Description

MonthlyFuncFromDay returns monthly values converted by a function from daily values.

Usage

```
MonthlyFuncFromDay(yearDF, datecol=1,valcol=2, mfunc=mean)
```

Arguments

yearDF	dataframe with climate data
datecol	column with dates
valcol	column with values
mfunc	function to apply on the data

Value

Monthly values.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville <- ReadGHCNymd('xgdcnCA008201000.dat')
MonthlyMeanCollegeville <- MonthlyFuncFromDay(dailyCollegeville)
```

MonthTrendYearsFuncFromDay

Monthly values converted from daily values

Description

MonthTrendYearsFuncFromDay returns monthly values converted by a function from daily values.

Usage

```
MonthTrendYearsFuncFromDay(yearDF, datecol=1,valcol=2, mfunc=mean, mmonth)
```

Arguments

yearDF	dataframe with climate data
datecol	column with dates
valcol	column with values
mfunc	function to apply on the data
mmonth	starting month

Value

Monthly values.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville <- ReadGHCNymd('xgdcnCA008201000.dat')
MonthlyCollegeville <- MonthTrendYearsFuncFromDay(dailyCollegeville, mmonth=1)
MonthlyCollegeville[,1] <- as.Date(MonthlyCollegeville[,1], origin = "1970-01-01")
```

---

peaksP *Use symbols to represent the level of significance*

Description

peaksP returns a certain number of marks depending on the level of significance achieved by the value statistic.

Usage

```
peaksP(dataSeries,span=3)
```

Arguments

dataSeries	time series of climate data
span	span, odd number

Value

symbols representing the level of significance.

Author(s)

Jose Gama

Source

R equivalent of Splus peaks() function

References

R equivalent of Splus peaks() function

Examples

```
peaksP(c(1,2,3,4,3,2,1))
```

Pettitt.Critical.Values *Critical values for the Pettitt test*

Description

`Pettitt.Critical.Values` contains the critical values for the Pettitt test.

Usage

```
Pettitt.Critical.Values
```

Format

This data frame contains 2 columns (95 and 6 rows (n=10, 20, 30, 40, 50, 100) of data.

Author(s)

Jose Gama

Source

Buishand TA., 1981 The analysis of homogeneity of long-term rainfall records in the Netherlands. KNMI Scientific Report WR 81-7, De Bilt, The Netherlands.

References

Buishand TA., 1981 The analysis of homogeneity of long-term rainfall records in the Netherlands. KNMI Scientific Report WR 81-7, De Bilt, The Netherlands.

Examples

```
data(Pettitt.Critical.Values)
Pettitt.Critical.Values
```

PettittTest *Pettitt test*

Description

`PettittTest` returns the result of the Pettitt test applied to a time series.

Usage

```
PettittTest(dataSeries)
```

Arguments

dataSeries	time series of climate data

Value

The result of the Pettitt test.

Author(s)

Jose Gama

Source

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

References

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

Examples

```
# Pettitt range test for Turin 1961-2003
PettittTurin<- PettittTest(yearly.average.temperature.Turin.Milan[,2])

# Pettitt range test for Milan 1961-2003
PettittMilan<- PettittTest(yearly.average.temperature.Turin.Milan[,3])

plot(1961:2003,PettittTurin,type='l',col='cyan',ylim=c(-400,0),
main='Pettitt range test 1961-2003',xlab='Years',ylab='Pettitt value')
par(new=TRUE)
plot(1961:2003,PettittMilan,type='l',col='magenta',ylim=c(-400,0),xlab='',ylab='')
legend("top",c('Turin','Milan'),text.col=c('cyan','magenta'))
```

PlotHomog *Plot the graphics for many homogenization methods*

Description

PlotHomog plot the graphics for many homogenization methods with an indication of the peak and significance levels.

Usage

```
PlotHomog(dataYearSeries=NA,refYearSeries=NA,diffFlag=TRUE,
homogenization=SNHTabsolute,levelSignificance=c(99,95),
criticalValues=climtrends::SNHT.Critical.Values,posLegend="topright",rowbycol=NULL)
```

Arguments

dataYearSeries	dataframe with climate data
refYearSeries	dataframe with climate data (reference)
diffFlag	logical TRUE=difference, FALSE=ratio
homogenization	homogenization test
levelSignificance	level of significance
criticalValues	critical values for the homogenization test
posLegend	position of the legend
rowbycol	vector with (rows, columns)

Value

none.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville <- ReadGHCNymd('xgdcnCA008201000.dat')
yearlyCollegeville=YearFuncFromDay(dailyCollegeville)
colnames(yearlyCollegeville) <- c('year','temperature')
PlotHomog(yearlyCollegeville)
```

PlotSeriesAndRefSimple

Plot a series and one or more reference series

Description

PlotSeriesAndRefSimple plot a series and one or more reference series. Similar to Anclim's "Analyzing Plot Series".

Usage

```
PlotSeriesAndRefSimple(dataYearSeries=NA,refYearSeries=NA)
```

Arguments

dataYearSeries	dataframe with climate data
refYearSeries	dataframe with climate data (reference)

Value

none.

Author(s)

Jose Gama

Examples

```
setwd(system.file('extdata/', package='climtrends'))
fm1<-read.delim('c_Casl_3.txt',sep='',header=FALSE)
fmRef <- read.delim('c_casl_O_3_REF.TXT',sep='',header=FALSE)
PlotSeriesAndRefSimple(fm1[,c(1,12)],fmRef[,c(1,12)])
```

PlotSeriesDifference *Plot the difference between 2 series*

Description

PlotSeriesDifference plot the difference between 2 series (series - reference series). Similar to Anclim's "Plot of Differences".

Usage

```
PlotSeriesDifference(dataYearSeries=NA,refYearSeries=NA, diffFlag=TRUE)
```

Arguments

dataYearSeries	dataframe with climate data
refYearSeries	dataframe with climate data (reference)
diffFlag	logical TRUE=difference, FALSE=ratio

Value

none.

Author(s)

Jose Gama

Examples

```
setwd(system.file('extdata/', package='climtrends'))
fm1<-read.delim('c_Casl_3.txt',sep='',header=FALSE)
fmRef <- read.delim('c_casl_O_3_REF.TXT',sep='',header=FALSE)
PlotSeriesDifference(fm1[,c(1,12)],fmRef[,c(1,12)])
```

Rank.Von.Neumann.Ratio.Test.Critical.Values

Critical values for the Rank Von-Neumann Ratio Test

Description

`Rank.Von.Neumann.Ratio.Test.Critical.Values` contains the critical values for the Rank Von-Neumann Ratio Test.

Usage

```
Rank.Von.Neumann.Ratio.Test.Critical.Values
```

Format

This data frame contains 6 columns (Q90 and 7 rows (n=10, 20, 30, 40, 50, 100 and Inf) of data.

Author(s)

Jose Gama

Source

Robert Bartels, 1982 The Rank Version of von Neumann's Ratio Test for Randomness Journal of the American Statistical Association Vol. 77, No. 377 pp. 40-46 http://www.jstor.org/stable/2287767

References

Robert Bartels, 1982 The Rank Version of von Neumann's Ratio Test for Randomness Journal of the American Statistical Association Vol. 77, No. 377 pp. 40-46 http://www.jstor.org/stable/2287767

Examples

```
data(Rank.Von.Neumann.Ratio.Test.Critical.Values)
Rank.Von.Neumann.Ratio.Test.Critical.Values
```

`RankDifferenceTest` *Rank Difference test (non-parametric test for randomness)*

Description

`RankDifferenceTest` returns the result of the Rank Difference test (non-parametric test for randomness) applied to a time series.

Usage

```
RankDifferenceTest(dataSeries)
```

Arguments

`dataSeries`	vector with climate data

Value

The result of the Rank Difference test.

Author(s)

Jose Gama

Source

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

References

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

Examples

```
x=c(681,3661,8625,2475,573,2794,10190,5143,4139,8945,7295,19883,12119,8772,
8848,16309,16254,2303,7671,3985,
13742,5333,4859,12381,12137,6075,4669,378,7507,3891,13046,12954,2445,14759,
20200,16331,6922,6739,11629,
7351,2445,9960,10,11786,10214,11216,8393,10005,6896,11632)
RankDifferenceTest(x)
```

RankSumTest *Rank Sum test*

Description

RankSumTest returns the result of the Rank Sum test (non-parametric test for difference in median from two data periods) applied to a time series.

Usage

```
RankSumTest(dataSeries, period1)
```

Arguments

dataSeries	time series of climate data
period1	first period

Value

The result of the Rank Sum test.

Author(s)

Jose Gama

Source

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

References

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

Examples

```
x=c(681,3661,8625,2475,573,2794,10190,5143,4139,8945,7295,19883,12119,8772,
8848,16309,16254,2303,7671,3985,
13742,5333,4859,12381,12137,6075,4669,378,7507,3891,13046,12954,2445,14759,
20200,16331,6922,6739,11629,
7351,2445,9960,10,11786,10214,11216,8393,10005,6896,11632)
RankSumTest(x, 20)
```

ReadClimexpKnmiNL *Read KNMI Climate Explorer files*

Description

`ReadClimexpKnmiNL` reads KNMI Climate Explorer files.

Usage

```
ReadClimexpKnmiNL(filename)
```

Arguments

`filename`	File name

Value

A dataframe with the read data.

Author(s)

Jose Gama

ReadClimexpKnmiNL12month *Read monthly values KNMI Climate Explorer files*

Description

ReadClimexpKnmiNL12month reads a monthly values file in climexp.knmi.nl format.

Usage

```
ReadClimexpKnmiNL12month(filename)
```

Arguments

filename	File name

Value

A dataframe with the read data.

Author(s)

Jose Gama

ReadCRDEC *Read GHCN-D files*

Description

ReadCRDEC reads a file from GHCN-D Canada, with date+Q into a dataframe.

Usage

```
ReadCRDEC(filename, FlagAnnualMean = F)
```

Arguments

filename	File name
FlagAnnualMean	Logical, if TRUE then return the annual mean instead of the monthly values

Value

A dataframe with the read data.

Author(s)

Jose Gama

ReadECAdata *Read data from a ECA data file*

Description

ReadECAdata reads data from a file downloaded from the European Climate Assessment & Dataset project.

Usage

```
ReadECAdata(filename)
```

Arguments

filename	File name

Value

A matrix with the read data.

Author(s)

Jose Gama

ReadEtmgegFile *Read USHCN files*

Description

ReadEtmgegFile reads a file from the Royal Netherlands Meteorological Institute (KNMI) into a dataframe.

Usage

```
ReadEtmgegFile(filename, optCols = NULL)
```

Arguments

filename	File name
optCols	user select colums

Value

A dataframe with the read data.

Author(s)

Jose Gama

Examples

```
# data from the ECA station series of Eelde (The Netherlands) from 1900 to 2000
EtmgegData<-ReadEtmgegFile('etmgeg_280.txt',c(2,12,13,15))
```

ReadGHCNymd *Read GHCN-Daily files*

Description

ReadGHCNymd reads Global Historical Climatology Network-Daily (GHCN-Daily) files.

Usage

```
ReadGHCNymd(filename)
```

Arguments

filename	File name

Value

A dataframe with the read data.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville=ReadGHCNymd('xgdcnCA008201000.dat')
```

ReadHERTTAdailyCSV *Read HERTTA files*

Description

ReadHERTTAdailyCSV reads a file from Finland's Environmental centre (HERTTA) into a dataframe.

Usage

```
ReadHERTTAdailyCSV(filename)
```

Arguments

filename	File name

Value

A dataframe with the read data.

Author(s)

Jose Gama

ReadHERTTAdmyQdaily *Read HERTTA month+year+Q files*

Description

ReadHERTTAdmyQdaily reads a month+year+Q file from Finland's Environmental centre (HERTTA) into a dataframe.

Usage

```
ReadHERTTAdmyQdaily(filename)
```

Arguments

filename	File name

Value

A dataframe with the read data.

Author(s)

Jose Gama

ReadMeteoSwiss *Read MeteoSwiss files*

Description

`ReadMeteoSwiss` reads a daily values file from MeteoSwiss.

Usage

```
ReadMeteoSwiss(filename)
```

Arguments

`filename`	File name

Value

A dataframe with the read data.

Author(s)

Jose Gama

ReadNdp040stationDat *Read data from a CDIAC data file*

Description

`ReadNdp040stationDat` reads data from a file downloaded from the Carbon Dioxide Information Analysis Center (CDIAC). Daily Temperature and Precipitation Data for 223 Former-USSR Stations.

Usage

```
ReadNdp040stationDat(filename)
```

Arguments

`filename`	File name

Value

A matrix with the read data.

Author(s)

Jose Gama

ReadPSMSLmonthly *Read PSMSL files*

Description

ReadPSMSLmonthly reads a file from the Permanent Service for Mean Sea Level (PSMSL) into a dataframe.

Usage

```
ReadPSMSLmonthly(filename)
```

Arguments

filename	File name

Value

A dataframe with the read data.

Author(s)

Jose Gama

ReadUSGS2timeseries *Read a a USGS discharge file*

Description

ReadUSGS2timeseries reads a .part file which is a USGS discharge file.

Usage

```
ReadUSGS2timeseries(filename)
```

Arguments

filename	File name

Value

A matrix with the read data.

Author(s)

Jose Gama

ReadUSHCN *Read USHCN files*

Description

ReadUSHCN reads a file from the United States Historical Climatology Network (USHCN) into a dataframe.

Usage

```
ReadUSHCN(filename)
```

Arguments

filename	File name

Value

A dataframe with the read data.

Author(s)

Jose Gama

ReadYearAnd12MonthsData *Read a TAB delimited data file with year and months in columns*

Description

ReadYearAnd12MonthsData reads a monthly values file with the data as y + 12 months in 1 line.

Usage

```
ReadYearAnd12MonthsData(filename)
```

Arguments

filename	File name

Value

A matrix with the read data.

Author(s)

Jose Gama

SiegelTukey *annual mean of the absolute day-to-day differences of DTR (Siegel-Tukey)*

Description

SiegelTukey returns the annual mean of the absolute day-to-day differences of the diurnal temperature range (SiegelTukey).

Usage

```
SiegelTukey(x,y,id.col=FALSE,adjust.median=FALSE,rnd=-1,alternative="two.sided",
mu=0 ,paired=FALSE,exact=FALSE,correct=TRUE,conf.int=FALSE,conf.level=0.95,
showresult=TRUE, returnresult=TRUE)
```

Arguments

x	vector of data
y	Data of the second group (if id.col=FALSE) or group indicator (if id.col=TRUE). In the latter case, y MUST take 1 or 2 to indicate observations of group 1 and 2, respectively, and x must contain the data for both groups.
id.col	If FALSE (default), then x and y are the data columns for group 1 and 2, respectively. If TRUE, the y is the group indicator.
adjust.median	Should between-group differences in medians be leveled before performing the test? In certain cases, the Siegel-Tukey test is susceptible to median differences and may indicate significant differences in variability that, in reality, stem from differences in medians.
rnd	Should the data be rounded and, if so, to which decimal? The default (-1) uses the data as is. Otherwise, rnd must be a non-negative integer. Typically, this option is not needed. However, occasionally, differences in the precision with which certain functions return values cause the merging of two data frames to fail within the SiegelTukey function. Only then rounding is necessary. This operation should not be performed if it affects the ranks of observations.
alternative	"one.sided" or "two.sided".
mu	mu.
paired	Logical, TRUE=paired, FALSE=not paired.
exact	Logical, TRUE=paired, FALSE=.
correct	Logical, TRUE=paired, FALSE=.
conf.int	Confidence interval.
conf.level	Confidence level.
showresult	Logical, show the result or not.
returnresult	Logical, return the result or not.

Value

`groupmedian1` Group median 1

`groupmedian2` Group median 2

`testmediandifferences`
Wilcoxon-test for between-group differences in median (after the median adjustment if specified)

`wilcox.test.p.value`
Wilcoxon-test for between-group differences in median (after the median adjustment if specified)

`wilcox.test.null.value`
Wilcoxon-test for between-group differences in median (after the median adjustment if specified)

`unique.x.tieadjusted.rank`
Unique values of x and their tie-adjusted Siegel-Tukey ranks

`tieadjusted.ranks.group1`
Tie-adjusted Siegel-Tukey ranks of group 1

`tieadjusted.ranks.group2`
Tie-adjusted Siegel-Tukey ranks of group 2

`wilcoxon.W` Wilcoxon-test for between-group differences in median (after the median adjustment if specified)

`wilcoxon.p.value`
Wilcoxon-test for between-group differences in median (after the median adjustment if specified)

Author(s)

Daniel Malter

Source

Daniel Malter, 2012 https://stat.ethz.ch/pipermail/r-help/2010-February/229215.html

References

Sidney Siegel and John Wilder Tukey, 1960 A nonparametric sum of ranks procedure for relative spread in unpaired samples. Journal of the American Statistical Association.

David J. Sheskin, 2004 Handbook of parametric and nonparametric statistical procedures. 3rd edition. Chapman and Hall/CRC. Boca Raton, FL.

Richard H. McCuen, 2002 Modeling Hydrologic Change: Statistical Methods CRC Press

Examples

```
x=c(4,4,5,5,6,6)
y=c(0,0,1,9,10,10)
SiegelTukey(x,y)
```

SNHT.Critical.Values *Critical values for the Pettitt test*

Description

SNHT.Critical.Values contains the critical values for the SNHT test from Khaliq and Ouarda, 2007. SNHT.Critical.Values.Alexandersson1997 has the data from Alexandersson 1997, which is used in AnClim.

Usage

```
SNHT.Critical.Values
```

Format

This data frame contains 2 columns (90.00 and 108 rows (n=10, 12, 14, 16, ..., 15000, 20000, 50000) of data.

Author(s)

Jose Gama

Source

Khaliq, M. N., Ouarda, T. B. M. J. 2007 On the critical values of the standard normal homogeneity test (SNHT) International Journal of Climatology John Wiley & Sons, Ltd. http://dx.doi.org/10.1002/joc.1438

References

Khaliq, M. N., Ouarda, T. B. M. J. 2007 On the critical values of the standard normal homogeneity test (SNHT) International Journal of Climatology John Wiley & Sons, Ltd. http://dx.doi.org/10.1002/joc.1438

Examples

```
data(SNHT.Critical.Values)
SNHT.Critical.Values
```

SNHT.TwoDifferentSDs.Critical.Values

Critical values for the standard normal homogeneity test (SNHT) for two different SDs

Description

SNHT.TwoDifferentSDs.Critical.Values contains the critical values for the SNHT test for 2 different SDs from Alexandersson and Moberg (1997).

Usage

```
SNHT.TwoDifferentSDs.Critical.Values
```

Format

This data frame contains 2 columns (90.00 and 108 rows (n=10, 12, 14, 16, ..., 15000, 20000, 50000) of data.

Author(s)

Jose Gama

Source

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

References

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

Examples

```
data(SNHT.TwoDifferentSDs.Critical.Values)
SNHT.TwoDifferentSDs.Critical.Values
```

SNHT.TwoShifts.Critical.Values *Critical values for the standard normal homogeneity test (SNHT) for two shifts*

Description

SNHT.TwoShifts.Critical.Values contains the critical values for the SNHT test for 2 shifts from Alexandersson (1995).

Usage

```
SNHT.TwoShifts.Critical.Values
```

Format

This data frame contains 2 columns (90.00 and 108 rows (n=10, 12, 14, 16, ..., 15000, 20000, 50000) of data.

Author(s)

Jose Gama

Source

Alexandersson, H., 1995. Homogeneity testing, multiple breaks and trends. Proceedings of the Sixth International Meeting on Statistical Climatology, Galway, Ireland, 439-441.

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

References

Alexandersson, H., 1995. Homogeneity testing, multiple breaks and trends. Proceedings of the Sixth International Meeting on Statistical Climatology, Galway, Ireland, 439-441.

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

Examples

```
data(SNHT.TwoShifts.Critical.Values)
SNHT.TwoShifts.Critical.Values
```

SNHTabsolute *standard normal homogeneity test (SNHT) absolute homogeneity test*

Description

SNHTabsolute returns the result of the standard normal homogeneity test (SNHT) absolute homogeneity test applied to a time series.

Usage

```
SNHTabsolute(dataSeries)
```

Arguments

dataSeries	time series of climate data

Value

The result of the SNHT absolute homogeneity test.

Author(s)

Jose Gama

Source

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

References

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

Examples

```
# standard normal homogeneity test (SNHT) for Turin 1961-2003
testTurin<- SNHTabsolute(yearly.average.temperature.Turin.Milan[,2])

# standard normal homogeneity test (SNHT) for Milan 1961-2003
testMilan<- SNHTabsolute(yearly.average.temperature.Turin.Milan[,3])

plot(1961:2002,testTurin,type='l',col='cyan',ylim=c(0,20),
main='standard normal homogeneity test (SNHT) 1961-2003',xlab='Years',ylab='test value')
par(new=TRUE)
plot(1961:2002,testMilan,type='l',col='magenta',ylim=c(0,20),xlab='',ylab='')
legend("top",c('Turin','Milan'),text.col=c('cyan','magenta'))
```

SNHTabsolute2SDs *standard normal homogeneity test (SNHT) absolute homogeneity test for two different SDs*

Description

SNHTabsolute2SDs returns the result of the standard normal homogeneity test (SNHT) absolute homogeneity test for two different SDs applied to a time series.

Usage

```
SNHTabsolute2SDs(dataSeries)
```

Arguments

dataSeries	time series of climate data

Value

The result of the SNHT absolute homogeneity test for two different SDs.

Author(s)

Jose Gama

Source

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

References

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

Examples

```
# standard normal homogeneity test (SNHT) for Turin 1961-2003
testTurin<- SNHTabsolute2SDs(yearly.average.temperature.Turin.Milan[,2])

# standard normal homogeneity test (SNHT) for Milan 1961-2003
testMilan<- SNHTabsolute2SDs(yearly.average.temperature.Turin.Milan[,3])

plot(1961:2000,testTurin,type='l',col='cyan',ylim=c(0,30),
main='standard normal homogeneity test (SNHT) 2 SDs 1961-2003',xlab='Years',ylab='test value')
par(new=TRUE)
plot(1961:2000,testMilan,type='l',col='magenta',ylim=c(0,30),xlab='',ylab='')
legend("top",c('Turin','Milan'),text.col=c('cyan','magenta'))
```

SNHTabsoluteDoubleShift

standard normal homogeneity test (SNHT) absolute homogeneity test for two shifts

---

Description

SNHTabsoluteDoubleShift returns the result of the standard normal homogeneity test (SNHT) absolute homogeneity test for two shifts applied to a time series.

Usage

```
SNHTabsoluteDoubleShift(dataSeries)
```

Arguments

dataSeries	time series of climate data

Value

SNHTdata	T SNHT absolute homogeneity test for trends
PosSecondShift	estimated position of the second shift

Author(s)

Jose Gama

Source

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

References

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

Examples

```
# standard normal homogeneity test for two shifts(SNHT) for Turin 1961-2003
testTurin<- SNHTabsoluteDoubleShift(yearly.average.temperature.Turin.Milan[,2])$SNHTdata

# standard normal homogeneity test for two shifts(SNHT) for Milan 1961-2003
testMilan<- SNHTabsoluteDoubleShift(yearly.average.temperature.Turin.Milan[,3])$SNHTdata

plot(1961:2002,testTurin,type='l',col='cyan',ylim=c(0,30),
main='standard normal homogeneity test (SNHT) for two shifts 1961-2003',
xlab='Years',ylab='test value')
par(new=TRUE)
plot(1961:2002,testMilan,type='l',col='magenta',ylim=c(0,30),xlab='',ylab='')
legend("top",c('Turin','Milan'),text.col=c('cyan','magenta'))
```

SNHTabsoluteII *standard normal homogeneity test (SNHT) absolute homogeneity test, SD different from 1*

Description

SNHTabsoluteII returns the result of the standard normal homogeneity test (SNHT) absolute homogeneity test with standard deviation different from 1, applied to a time series.

Usage

```
SNHTabsoluteII(dataSeries)
```

Arguments

dataSeries	time series of climate data

Value

The result of the SNHT absolute homogeneity test with SD != 1.

Author(s)

Jose Gama

Source

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

References

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

Examples

```
# standard normal homogeneity test, SD different from 1(SNHT) for Turin 1961-2003
testTurin<- SNHTabsoluteII(yearly.average.temperature.Turin.Milan[,2])

# standard normal homogeneity test, SD different from 1(SNHT) for Milan 1961-2003
testMilan<- SNHTabsoluteII(yearly.average.temperature.Turin.Milan[,3])

plot(1961:2002,testTurin,type='l',col='cyan',ylim=c(0,30),
main='standard normal homogeneity test (SNHT), SD different from 1 for 1961-2003',
xlab='Years',ylab='test value')
par(new=TRUE)
plot(1961:2002,testMilan,type='l',col='magenta',ylim=c(0,30),xlab='',ylab='')
legend("top",c('Turin','Milan'),text.col=c('cyan','magenta'))
```

SNHTabsoluteTrend *standard normal homogeneity test (SNHT) absolute homogeneity test for trends*

Description

SNHTabsoluteTrend returns the result of the standard normal homogeneity test (SNHT) absolute homogeneity test for trends applied to a time series.

Usage

```
SNHTabsoluteTrend(dataSeries)
```

Arguments

dataSeries	time series of climate data

Value

SNHTdata	T SNHT absolute homogeneity test for trends
PosStartTrend	estimated start position of the trend

Author(s)

Jose Gama

Source

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

References

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

Examples

```
# standard normal homogeneity test for trends(SNHT) for Turin 1961-2003
testTurin<- SNHTabsoluteTrend(yearly.average.temperature.Turin.Milan[,2])$SNHTdata

# standard normal homogeneity test for trends(SNHT) for Milan 1961-2003
testMilan<- SNHTabsoluteTrend(yearly.average.temperature.Turin.Milan[,3])$SNHTdata

plot(1961:2002,testTurin,type='l',col='cyan',ylim=c(0,30),
main='standard normal homogeneity test (SNHT) for trends, 1961-2003',xlab='Years',ylab='test value')
par(new=TRUE)
plot(1961:2002,testMilan,type='l',col='magenta',ylim=c(0,30),xlab='',ylab='')
legend("top",c('Turin','Milan'),text.col=c('cyan','magenta'))
```

SNHTrelative *standard normal homogeneity test (SNHT) relative homogeneity test*

Description

SNHTrelative returns the result of the standard normal homogeneity test (SNHT) relative homogeneity test applied to a time series.

Usage

```
SNHTrelative(dataSeries,refSeries=NA, diffFlag=TRUE)
```

Arguments

dataSeries	time series of climate data
refSeries	dataframe with climate data (reference)
diffFlag	logical TRUE=difference, FALSE=ratio

Value

The result of the SNHT relative homogeneity test.

Author(s)

Jose Gama

Source

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

References

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

SNHTrelative2SDs *standard normal homogeneity test (SNHT) relative homogeneity test for two different SDs*

Description

SNHTrelative2SDs returns the result of the standard normal homogeneity test (SNHT) relative homogeneity test for two different SDs applied to a time series.

Usage

```
SNHTrelative2SDs(dataSeries,refSeries=NA, diffFlag=TRUE)
```

Arguments

dataSeries	time series of climate data
refSeries	dataframe with climate data (reference)
diffFlag	logical TRUE=difference, FALSE=ratio

Value

The result of the SNHT relative homogeneity test for two different SDs.

Author(s)

Jose Gama

Source

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

References

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

SNHTrelativeDoubleShift

standard normal homogeneity test (SNHT) relative homogeneity test for two shifts

---

Description

`SNHTrelativeDoubleShift` returns the result of the standard normal homogeneity test (SNHT) relative homogeneity test for two shifts applied to a time series.

Usage

```
SNHTrelativeDoubleShift(dataSeries,refSeries=NA, diffFlag=TRUE)
```

Arguments

`dataSeries`	time series of climate data
`refSeries`	dataframe with climate data (reference)
`diffFlag`	logical TRUE=difference, FALSE=ratio

Value

`SNHTdata`	T SNHT relative homogeneity test for trends
`PosSecondShift`	estimated position of the second shift

Author(s)

Jose Gama

Source

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

References

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

SNHTrelativeII *standard normal homogeneity test (SNHT) relative homogeneity test, SD different from 1*

Description

`SNHTrelativeII` returns the result of the standard normal homogeneity test (SNHT) relative homogeneity test with standard deviation different from 1, applied to a time series.

Usage

```
SNHTrelativeII(dataSeries,refSeries=NA, diffFlag=TRUE)
```

Arguments

`dataSeries`	time series of climate data
`refSeries`	dataframe with climate data (reference)
`diffFlag`	logical TRUE=difference, FALSE=ratio

Value

The result of the SNHT relative homogeneity test with SD != 1.

Author(s)

Jose Gama

Source

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

References

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

`SNHTrelativeTrend` *standard normal homogeneity test (SNHT) relative homogeneity test for trends*

Description

`SNHTrelativeTrend` returns the result of the standard normal homogeneity test (SNHT) relative homogeneity test for trends applied to a time series.

Usage

```
SNHTrelativeTrend(dataSeries,refSeries=NA, diffFlag=TRUE)
```

Arguments

`dataSeries`	time series of climate data
`refSeries`	dataframe with climate data (reference)
`diffFlag`	logical TRUE=difference, FALSE=ratio

Value

`SNHTdata`	T SNHT relative homogeneity test for trends
`PosStartTrend`	estimated start position of the trend

Author(s)

Jose Gama

Source

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

References

ALEXANDERSSON, H. and MOBERG, A. (1997), HOMOGENIZATION OF SWEDISH TEMPERATURE DATA. PART I: HOMOGENEITY TEST FOR LINEAR TRENDS. Int. J. Climatol., 17: 25–34. doi: 10.1002/(SICI)1097-0088(199701)17:1<25::AID-JOC103>3.0.CO;2-J

Tuomenvirta, H., 2002: Homogeneity testing and adjustment of climatic time series in Finland. Geophysica, 38(1-2), 15-41.

`Sqplot` *Number of elements for a plot to be nearly square*

Description

`Sqplot` returns the number of elements for a plot to be nearly square.

Usage

```
Sqplot(n)
```

Arguments

`n`	number of elements

Value

vector with number of rows and columns.

Author(s)

Jose Gama

Examples

```
Sqplot(10)
```

`TietjenMoore` *Tietjen Moore statistic*

Description

`TietjenMoore` returns the Tietjen Moore statistic.

Usage

```
TietjenMoore(dataSeries,k)
```

Arguments

`dataSeries`	time series of climate data
`k`	number of outliers

Value

The Tietjen Moore statistic.

Author(s)

Jose Gama

Source

NIST/SEMATECH e-Handbook of Statistical Methods, 2013 http://www.itl.nist.gov/div898/handbook/

References

NIST/SEMATECH e-Handbook of Statistical Methods, 2013 http://www.itl.nist.gov/div898/handbook/

Examples

```
TietjenMoore(c(2, 4, 6, 7, 11, 21, 81, 90, 105, 121), 2)
```

TrimmedMean *trimmed mean*

Description

TrimmedMean returns the trimmed mean of a time series.

Usage

```
TrimmedMean(dataSeries, percentTrim=0.1)
```

Arguments

dataSeries	time series
percentTrim	percentage to trim

Value

The trimmed mean of a time series.

Author(s)

Jose Gama

Examples

```
TrimmedMean(1:10)
```

TurningPointsTest *Turning Points (non-parametric test for randomness)*

Description

TurningPointsTest returns the result of the Turning Points (non-parametric test for randomness) applied to a time series.

Usage

```
TurningPointsTest(dataSeries)
```

Arguments

dataSeries	vector with climate data

Value

The result of the Turning Points test.

Author(s)

Jose Gama

Source

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

References

Chiew F. and Siriwardena L., 2005 CRC for Catchment Hydrology Trend 1.0.2 User Guide, chapter 4.2.11 Rank Difference Test, pp. 21 http://www.toolkit.net.au/Tools/TREND/documentation

Kundzewicz, Z.W. and Robson, A., 2000 Detecting Trend and Other Changes in Hydrological Data. World Climate Program - Water, WMO/UNESCO, WCDMP-45, WMO/TD 1013, Geneva, 157 pp.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A. and Mein, R., 1996 Hydrological Recipes: Estimation Techniques in Australian Hydrology. Cooperative Research Centre for Catchment Hydrology, Australia, 125 pp.

Examples

```
x=c(681,3661,8625,2475,573,2794,10190,5143,4139,8945,7295,19883,12119,8772,
8848,16309,16254,2303,7671,3985,
13742,5333,4859,12381,12137,6075,4669,378,7507,3891,13046,12954,2445,14759,
20200,16331,6922,6739,11629,
7351,2445,9960,10,11786,10214,11216,8393,10005,6896,11632)
TurningPointsTest(x)
```

ValuesBetween2Dates *Get values between two dates*

Description

`ValuesBetween2Dates` returns all the values between two dates, inclusively.

Usage

```
ValuesBetween2Dates(dataYearSeries,FromDate,ToDate)
```

Arguments

dataYearSeries	dataframe with climate data
FromDate	starting date
ToDate	ending date

Value

values between two dates.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville <- ReadGHCNymd('xgdcnCA008201000.dat')
dailyCollegeville0910 <- ValuesBetween2Dates(dailyCollegeville,'2009-01-01','2010-12-30')
```

ValuesBetween2years *Get values between two years*

Description

ValuesBetween2years returns all the values between 2 years, that is, the 1st and the last days of a year range.

Usage

```
ValuesBetween2years(dataYearSeries,intFromYear,intToYear)
```

Arguments

dataYearSeries	dataframe with climate data
intFromYear	starting year
intToYear	ending year

Value

values between two years.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville=ReadGHCNymd('xgdcnCA008201000.dat')
yearlyCollegeville=YearFuncFromDay(dailyCollegeville)
colnames(yearlyCollegeville) <- c('year','temperature')
yearlyCollegeville<-ValuesBetween2years(yearlyCollegeville,1918,1993)
```

VDTR *annual mean of the absolute day-to-day differences of DTR (VDTR)*

Description

VDTR returns the annual mean of the absolute day-to-day differences of the diurnal temperature range (VDTR).

Usage

```
VDTR(yearDF,datecol,valcol)
```

Arguments

yearDF	matrix with diurnal temperature range data
datecol	column with dates
valcol	column with diurnal temperature range data

Value

absolute day-to-day differences of the diurnal temperature range (VDTR).

Author(s)

Jose Gama

Source

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

References

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

Examples

```
# data from the ECA station series of Eelde (The Netherlands) from 1900 to 2000
EtmgegData<-ReadEtmgegFile('etmgeg_280.txt',c(2,12,13,15))
until2000<-EtmgegData[which(EtmgegData[,1]<'2001-01-01'),] # zr are the data until 2000
until2000[,2:4]<-until2000[,2:4]/10 # divide by 10 to get a scale of 1 degrees Celsius
# calculate DTR
u2000DTR<-until2000[,-2] #get rid of the mean
u2000DTR[,2]<-u2000DTR[,3]-u2000DTR[,2] #DTR=MAX-MIN
u2000DTR<-u2000DTR[,-3]
u2000mDTR<-YearMeanFromDay(u2000DTR,1,2)
# calculate VDTR
u2000VDTR<-VDTR(u2000DTR,1,2)
```

Von.Neumann.Ratio.Test.Critical.Values

Critical values for the Von Neumann ratio test

Description

`Von.Neumann.Ratio.Test.Critical.Values` contains the critical values for the Von Neumann ratio test.

Usage

```
Von.Neumann.Ratio.Test.Critical.Values
```

Format

This data frame contains 2 columns (1 and 6 rows (n=20, 30, 40, 50, 70 and 100) of data.

Author(s)

Jose Gama

Source

Von Neumann J., 1941 Distribution of the ratio of the mean square successive difference to the variance. Annals of Mathematical Statistics 13: 367–395.

References

Von Neumann J., 1941 Distribution of the ratio of the mean square successive difference to the variance. Annals of Mathematical Statistics 13: 367–395.

Examples

```
data(Von.Neumann.Ratio.Test.Critical.Values)
Von.Neumann.Ratio.Test.Critical.Values
```

VonNeumannRatio *Pettitt test*

Description

VonNeumannRatio returns the result of the Von Neumann ratio test applied to a time series.

Usage

```
VonNeumannRatio(dataSeries)
```

Arguments

dataSeries	time series of climate data

Value

The result of the Pettitt test.

Author(s)

Jose Gama

Source

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

Von Neumann J., 1941 Distribution of the ratio of the mean square successive difference to the variance. Annals of Mathematical Statistics 13: 367–395.

References

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

Von Neumann J., 1941 Distribution of the ratio of the mean square successive difference to the variance. Annals of Mathematical Statistics 13: 367–395.

Examples

```
# Von Neumann ratio test for Turin 1961-2003
testTurin<- VonNeumannRatio(yearly.average.temperature.Turin.Milan[,2])

# Von Neumann ratio test for Milan 1961-2003
testMilan<- VonNeumannRatio(yearly.average.temperature.Turin.Milan[,3])
```

VonNeumannRatioRank *Von Neumann ratio rank test*

Description

VonNeumannRatioRank returns the result of the Von Neumann ratio rank test applied to a time series.

Usage

```
VonNeumannRatioRank(dataSeries)
```

Arguments

dataSeries	time series of climate data

Value

The result of the Von Neumann ratio rank test.

Author(s)

Jose Gama

Source

Robert Bartels, 1982 The Rank Version of von Neumann's Ratio Test for Randomness Journal of the American Statistical Association Vol. 77, No. 377 pp. 40-46 http://www.jstor.org/stable/2287767

References

Robert Bartels, 1982 The Rank Version of von Neumann's Ratio Test for Randomness Journal of the American Statistical Association Vol. 77, No. 377 pp. 40-46 http://www.jstor.org/stable/2287767

Examples

```
# Von Neumann ratio rank test for Turin 1961-2003
testTurin<- VonNeumannRatioRank(yearly.average.temperature.Turin.Milan[,2])

# Von Neumann ratio rank test for Milan 1961-2003
testMilan<- VonNeumannRatioRank(yearly.average.temperature.Turin.Milan[,3])
```

WetDayCount *Get number of wet days*

Description

WetDayCount returns the number of wet days with a certain threshold in mm).

Usage

```
WetDayCount(yearDF, datecol, valcol, vthreshold)
```

Arguments

yearDF	dataframe with climate data
datecol	column with dates
valcol	column with precipitation data
vthreshold	threshold in mm

Value

number of wet days.

Author(s)

Jose Gama

Examples

```
setwd(system.file('extdata/', package='climtrends'))
z<-ReadECAdata('RR_SOUID101991.txt')
d1900.2000<-z[which(z[,1]<'2001-01-01'),]
d1900.2000<-d1900.2000[which(d1900.2000[,1]>='1900-01-01'),]
y1900.2000w<-WetDayCount(d1900.2000,1,2,10)
```

woOp *x without y*

Description

%w/o% returns TRUE if there are no matching values

Usage

```
x %w/o% y
```

Arguments

x	string
y	another string

Value

logical, TRUE = no matching values

Author(s)

Jose' Gama

Source

R documentation, Value Matching /urlhttp://stat.ethz.ch/R-manual/R-patched/library/base/html/match.html

References

R documentation, Value Matching /urlhttp://stat.ethz.ch/R-manual/R-patched/library/base/html/match.html

Examples

```
## Not run:
(1:10)
1950:1970

## End(Not run)
```

Worsley.Likelihood.Ratio.Test.Critical.Values

Critical values for Worsley's likelihood ratio test

Description

`Worsley.Likelihood.Ratio.Test.Critical.Values` contains the critical values for the Worsley's likelihood ratio test.

Usage

```
Worsley.Likelihood.Ratio.Test.Critical.Values
```

Format

This data frame contains 3 columns (alpha10 and 9 rows (n=10, 15, 20, 25, 30, 35, 40, 45, 50) of data.

Author(s)

Jose Gama

Source

Worsley, K.J., 1979 On the likelihood ratio test for a shift in location of normal populations. J. Am. Stat. Assoc., 74: 365–367.

References

Worsley, K.J., 1979 On the likelihood ratio test for a shift in location of normal populations. J. Am. Stat. Assoc., 74: 365–367.

Examples

```
data(Worsley.Likelihood.Ratio.Test.Critical.Values)
Worsley.Likelihood.Ratio.Test.Critical.Values
```

WorsleyLikelihoodRatio

Worsley's Likelihood Ratio test

Description

`WorsleyLikelihoodRatio` returns the result of Worsley's Likelihood Ratio test applied to a time series.

Usage

```
WorsleyLikelihoodRatio(yearDF, datecol=1,valcol=2, returnZk=FALSE)
```

Arguments

`yearDF`	dataframe with climate data
`datecol`	column with dates
`valcol`	column with values
`returnZk`	return calculated data Zk

Value

The result of Worsley's Likelihood Ratio test.

Author(s)

Jose Gama

Source

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

References

Wijngaard, J. B., Klein Tank, A. M. G. and Können, G. P. (2003), Homogeneity of 20th century European daily temperature and precipitation series. Int. J. Climatol., 23: 679–692. doi: 10.1002/joc.906

Examples

```
demo(demoWorsleyLR)
```

YearFuncFromDay *Annual values converted from daily values*

Description

YearFuncFromDay returns annual values converted by a function from daily values.

YearMeanFromDay returns annual values averaged from daily values.

Usage

```
YearFuncFromDay(yearDF, datecol=1,valcol=2, yfunc=mean)
```

Arguments

yearDF	dataframe with climate data
datecol	column with dates
valcol	column with values
yfunc	function to apply on the data

Value

Annual values.

Author(s)

Jose Gama

Examples

```
# xgdcnCA008201000.dat is from ECA COLLEGEVILLE temperature
setwd(system.file('extdata/', package='climtrends'))
dailyCollegeville=ReadGHCNymd('xgdcnCA008201000.dat')
yearlyCollegeville=YearFuncFromDay(dailyCollegeville)
```

`yearly.average.temperature.Turin.Milan`
Yearly average temperature in Turin, Milan

Description

`yearly.average.temperature.Turin.Milan` contains the yearly average temperature in Turin, Milan.

Usage

```
yearly.average.temperature.Turin.Milan
```

Format

This data frame contains 6 columns (Q90 and 7 rows (n=10, 20, 30, 40, 50, 100 and Inf) of data.

Author(s)

Jose Gama

Source

Historical Climatology Group, 2005 Training session on homogenisation methods Bologna 17-18 May, 2005

References

Historical Climatology Group, 2005 Training session on homogenisation methods Bologna 17-18 May, 2005

Examples

```
data(yearly.average.temperature.Turin.Milan)
str(yearly.average.temperature.Turin.Milan)
```

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