Package 'RMAWGEN'

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License GPL (>= 2)

Title Multi-Site Auto-Regressive Weather GENerator

Type Package

Description S3 and S4 functions are implemented for spatial multi-site stochastic generation of daily time series of temperature and precipitation. These tools make use of Vector AutoRegressive models (VARs). The weather generator model is then saved as an object and is calibrated by daily instrumental ``Gaussianized'' time series through the 'vars' package tools. Once obtained this model, it can it can be used for weather generations and be adapted to work with several climatic monthly time series.

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Depends R (>= 3.5.0), chron, date, vars, methods

Imports Matrix

Suggests lubridate

URL https://ecor.github.io/RMAWGEN/,https://github.com/ecor/RMAWGEN, https://docs.google.com/file/d/0B66otCUk3Bv6V3RPbm1mUG4zVHc/edit

RoxygenNote 7.3.2

NeedsCompilation no

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RMAWGEN-package *R - Multi-site Autoregressive WEather Generator*

Description

Multi-site autoregressive Models for Daily Weather Generation. The modeling in climate change applications for agricultural or hydrological purposes often requires daily time-series of precipitation and temperature. This is the case of downscaled series from monthly or seasonal predictions of Global Climate Models (GCMs). The R package RMAWGEN (R Multi-Sites Auto regressive Weather GENerator) is built to generate daily temperature and precipitation time series in several sites by using the theory of vectorial autoregressive models (VAR). The VAR model is used because it is able to maintain the temporal and spatial correlations among the several series. In particular, observed time series of daily maximum and minimum temperature and precipitation are used to calibrate the parameters of a VAR model (saved as "GPCAvarest2" or "varest2" classes, which inherit the "varest" S3 class defined in the package vars [Pfaff, 2008]). Therefore the VAR model, coupled with monthly mean weather variables downscaled by GCM predictions, allows to generate several stochastic daily scenarios. The structure of the package consists in functions that transform precipitation and temperature time series into Gaussian-distributed random variables through deseasonalization and Principal Component Analysis. Then a VAR model is calibrated on transformed time series. The time series generated by VAR are then inversely re transformed into precipitation and/or temperature series. An application dateset is included in the RMAWGEN package as an example; it is presented by using a dataset with daily weather time series recorded in 59 different sites of Trentino (Italy) and its neighborhoods for the period 1958-2007. The software is distributed as a Free Software with General Public License (GPL) and is available on CRAN and Github. A presentation of the package is available on https://docs.google.com/file/d/

0B66otCUk3Bv6V3RPbm1mUG4zVHc/edit. Example script files about package usage are available on https://github.com/ecor/RMAWGENCodeCorner.

Details

Package:	RMAWGEN
Type:	Package
Version:	1.3.6
Date:	2019-11-13
License:	GPL (>= 2)
LazyLoad:	yes
Depends:	R(>=2.12),time,chron,vars

Note

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Author(s)

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References

Cordano E. and Eccel E. (2016), Tools for stochastic weather series generation in R environment, Italian Journal of Agrometeorology doi:10.19199/2016.3.20385625.031

Pfaff B. (2008). VAR, SVAR and SVEC Models: Implementation Within R Package vars. Journal of Statistical Software 27(4). https://www.jstatsoft.org/v27/i04/(doi:10.18637/jss.v027.i04)

acvWGEN *Plots the auto- and cross- covariance functions between measured and simulated data for several stations*

Description

Plots the auto- and cross- covariance functions between measured and simulated data for several stations

Usage

```
acvWGEN(measured, simulated, titles = c("Sim.", "Mes."), station = NULL)
```

Arguments

measured	matrix containing measured time series
simulated	matrix containing simulated time series
titles	title suffixes for the simulated and measured data respectively c("Sim.","Mes.")
station	string vector containing the IDs of the meteorological stations where the auto-covariance is calculated. If it is NULL (default) all stations (corresponding to the columns of "simulated" and "measured") are applied

Value

0 in case of success

Note

It uses acf function

---

adddate *Inserts three columns (year,month,day) passing dates to a matrix or to a dataframe*

Description

Inserts three columns (year,month,day) passing dates to a matrix or to a dataframe

Usage

```
adddate(data, origin = "1961-1-1")
```

Arguments

data	matrix of daily data
origin	character string containing the date of the first row of data as YYYY-MM-DD

Value

a data frame with dates and data values

See Also

findDate

---

addsuffixes *Adds suffixes for daily maximum and minimum temperature to the names of a column data frame*

Description

Adds suffixes for daily maximum and minimum temperature to the names of a column data frame

Usage

```
addsuffixes(
  names = c("T0001", "T0099", "T0001", "T0099"),
  suffix = c("_Tx", "_Tn"),
  sep = ""
)
```

Arguments

names	a character string vector with column names
suffix	suffixes to add to the first and second groups of column names respectively
sep	separation element

Details

This function is used for data frames with duplicated field names

Value

the vector of names with suffixes added

See Also

getVARmodel

Examples

```
names <- addsuffixes()
```

arch_test arch.test *function for* varest2 *object*

Description

arch.test function for varest2 object

Usage

```
arch_test(object, interval = NULL, overlap = 20, list.output = FALSE, ...)
```

Arguments

object	a varest2 object
interval	string or subset interval of time (e.g. days) or length of this subset interval to which the ARCH test is applied (see Note). Default is NULL.
overlap	number of time instants (e.g. days) which are overlapped on two different subsequent intervals. Default is 20. It is used only if interval has length 1.
list.output	logical value. If TRUE the function returns a list of the test results of each interval. It is used if interval is not NULL. Default is FALSE.
...	further arguments for arch.test

Details

This function is a wrapper of arch.test. It can compute the test also for some subsets (intervals) of the time-series or for all the time-series divided in overlapping intervals. The intervals considered for the ARCH test are defined with the argument interval. If interval is an integer number instead of a vector, it indicates the length of the intervals in which the time-series is split. If interval is set to NULL, the test is done on the comprehensive residual time-series without splitting.

Value

One object or a list of objects with class attribute varcheck as reported in arch.test

See Also

arch.test

collinear_dataset *Collinear Dataset*

Description

It is an artificial example dataset contaning 16 variables with collinearity among some of them.

Usage

```
data(collinear_dataset)
```

Format

Data frame

Details

The user can easily use the package with his/her own data after replacing the values of such variables.

Source

This dataset is intended for research purposes only, being distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY.

ComprehensivePrecipitationGenerator
The comprehensive Precipitation Generator

Description

The comprehensive Precipitation Generator

Usage

```
ComprehensivePrecipitationGenerator(
  station = c("T0001", "T0010", "T0099"),
  prec_all,
  mean_climate_prec = NULL,
  year_max = 1990,
  year_min = 1961,
  leap = TRUE,
  nmonth = 12,
  cpf = NULL,
  verbose = TRUE,
  p = 1,
```

```
  type = "none",
  lag.max = NULL,
  ic = "AIC",
  activateVARselect = FALSE,
  exogen = NULL,
  exogen_sim = NULL,
  is_exogen_gaussian = FALSE,
  year_max_sim = year_max,
  year_min_sim = year_min,
  mean_climate_prec_sim = NULL,
  onlygeneration = FALSE,
  varmodel = NULL,
  type_quantile = 3,
  qnull = NULL,
  valmin = 0.5,
  step = 0,
  n_GPCA_iteration = 0,
  n_GPCA_iteration_residuals = n_GPCA_iteration,
  sample = NULL,
  extremes = TRUE,
  exogen_all = NULL,
  exogen_all_col = station,
  no_spline = FALSE,
  nscenario = 1,
  seed = NULL,
  noise = NULL,
  nearPD = FALSE
)
```

Arguments

station	character vector of the IDs of the considered meteorological stations
prec_all	data frame containing daily precipitation of all meteorological stations. See PRECIPITATION defined in the trentino dataset for formatting.
mean_climate_prec	a matrix containing monthly mean daily precipitation for the considered station. If it is NULL, it is calculated. See input of is.monthly.climate
year_max	start year of the recorded (calibration) period
year_min	end year of the recorded (calibration) period
leap	logical variables. If it is TRUE (default)(recommended), leap years are considered, otherwise all years have 365 days
nmonth	number of months in one year (default is 12)
cpf	see normalizeGaussian_severalstations
verbose	logical variable
p, type, lag.max, ic, activateVARselect	see respective input parameter on getVARmodel

exogen — data frame or matrix containing the (normalized or not) exogenous variables (predictors) for the recorded (calibration) period.

exogen_sim — data frame or matrix containing the (normalized or not) exogenous variables (predictors) for the simulation period. Default is NULL. If it is NULL, it is replaced with exogen within the function.

is_exogen_gaussian — logical value. If TRUE, exogen_sim and exogen are given as already normalized variables, otherwhise they are not normalized. Default is FALSE

year_max_sim — last year of the simulation period. Default is equal to year_max

year_min_sim — first year of the simulation period. Default is equal to year_min

mean_climate_prec_sim — a matrix containing monthly mean daily precipitation for the simulation period. If is NULL (Default), it is set equal to mean_climate_prec.

onlygeneration — logical value. If TRUE the VAR model varmodel is given as input and only random generation is done, otherwise (default) is calculated from measured data

varmodel — the comprehensinve VAR model as a varest2 S4 object or a NULL object. If NULL (default), the comprehensinve VAR is estimated from measured data within the function, otherwise it is given as input and only random generation is done.

type_quantile — see type on quantile

step — see normalizeGaussian_severalstations. Default is 0.

n_GPCA_iteration — number of iterations of Gaussianization process for data. Default is 0 (no Gaussianization)

n_GPCA_iteration_residuals — number of iterations of Gaussianization process for VAR residuals. Default is 0 (no Gaussianization)

sample, extremes, qnull, valmin — see normalizeGaussian_severalstations

exogen_all — data frame containing exogenous variable formatted like prec_all. Default is NULL. It is alternative to exogen and if it not NULL,is_exogen_gaussian is automatically set FALSE

exogen_all_col — vector of considered columns of exogen_all. Default is station.

no_spline — logical value. See splineInterpolateMonthlytoDailyforSeveralYears. Default is TRUE.

nscenario — number of generated scenarios for daily maximum and minimum temperature

seed — seed for stochastic random generation see set.seed.

noise — stochastic noise to add for variabile generation. Default is NULL. See newVARmultieventRealization. Not used in case that nscenario>1.

nearPD — logical. Default is FALSE. See getVARmodel.

Value

A list of the following variables:

`prec_mes` matrix containing measured daily precipitation (the data is copied by the measured data given as input for the period and the station considered for `varmodel` estimation)

`prec_spline` matrix containing climatic "spline-interpolated" daily preciptation from `mean_climate_prec`

`data_prec` matrix containing normalized measured precipitation variable

`prec_gen` matrix containing generated daily precipitation [mm]

`prec_spline_sim` matrix containing climatic "spline-interpolated" daily preciptation from `mean_climate_prec_sim`

`data_prec_gen` matrix containing normalized generated precipitation variable

`mean_climate_prec` matrix containing monthly means of daily precipitation (historical scenario)

`mean_climate_prec_sim` matrix containing monthly means of daily precipitation (predicted/simulated scenario)

`var` a varest object containing the used VAR model

Note

It pre-processes and generates a multi-site precipitation fields. It uses `getVARmodel`. Detailed examples can be viewed of this function in this presentation. Unfortunately, using this approach, the spatial correlations are underestimated. This is due to the persinstence of zeros in the precipitation records. This problem is known in literature and can be solved in the future versions of RMAWGEN. See the R code for further details

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

`splineInterpolateMonthlytoDailyforSeveralYears`

Examples

```
data(trentino)
set.seed(1222) # set the seed for random generations!
year_max <- 1990
year_min <- 1961
year_max_sim <- 1982
year_min_sim <- 1981

n_GPCA_iter <- 2
p <- 1
nscenario=1
station <- c("T0090","T0083")

## Not Run: the call to ComprehensivePrecipitationGenerator may elapse too
## long time (more than 5 eseconds) and is not executed  by default CRAN check.
## Please uncomment the following line to run the example on your own PC.
```

```
generation00 <- ComprehensivePrecipitationGenerator(station=station,
prec_all=PRECIPITATION,year_min=year_min,year_max=year_max,
year_min_sim=year_min_sim,year_max_sim=year_max_sim,p=p,
n_GPCA_iteration=n_GPCA_iter,n_GPCA_iteration_residuals=0,
sample="monthly",nscenario=nscenario,no_spline=TRUE)
```

ComprehensiveTemperatureGenerator

The Comprehensive Temperature Generator

Description

The Comprehensive Temperature Generator

Usage

```
ComprehensiveTemperatureGenerator(
  station = c("T0001", "T0010", "T0099"),
  Tx_all,
  Tn_all,
  mean_climate_Tn = NULL,
  mean_climate_Tx = NULL,
  Tx_spline = NULL,
  Tn_spline = NULL,
  year_max = 1990,
  year_min = 1961,
  leap = TRUE,
  nmonth = 12,
  verbose = TRUE,
  p = 1,
  type = "none",
  lag.max = NULL,
  ic = "AIC",
  activateVARselect = FALSE,
  year_max_sim = year_max,
  year_min_sim = year_min,
  mean_climate_Tn_sim = NULL,
  mean_climate_Tx_sim = NULL,
  Tn_spline_sim = NULL,
  Tx_spline_sim = NULL,
  onlygeneration = FALSE,
  varmodel = NULL,
  normalize = TRUE,
  type_quantile = 3,
```

```
  sample = NULL,
  extremes = TRUE,
  option = 2,
  yearly = FALSE,
  yearly_sim = yearly,
  n_GPCA_iteration = 0,
  n_GPCA_iteration_residuals = n_GPCA_iteration,
  exogen = NULL,
  exogen_sim = exogen,
  is_exogen_gaussian = FALSE,
  exogen_all = NULL,
  exogen_all_col = station,
  nscenario = 1,
  seed = NULL,
  noise = NULL,
  nearPD = FALSE
)
```

Arguments

station	see respective input parameter on setComprehensiveTemperatureGeneratorParameters
Tx_all, Tn_all, mean_climate_Tn, mean_climate_Tx, Tx_spline, Tn_spline	see respective input parameter on setComprehensiveTemperatureGeneratorParameters
year_max, year_min, leap, nmonth, verbose	see respective input parameter on setComprehensiveTemperatureGeneratorParameters
p, type, lag.max, ic, activateVARselect	see respective input parameter on getVARmodel
year_max_sim	last year of the simulation period. Default is equal to year_max
year_min_sim	first year of the simulation period. Default is equal to year_min
mean_climate_Tn_sim	monthly averaged daily minimum temperatures for the simulated scenario and used by the random generator . Default is mean_climate_Tn
mean_climate_Tx_sim	monthly averaged daily maximum temperatures for the simulated scenario and used by the random generator . Default is mean_climate_Tx
Tn_spline_sim	daily timeseries (from the first day of year_min_sim to the last day of year_max_sim) of averaged minimum temperature which can be obtained by a spline interpolation of monthly mean values (for the generation period). Default is Tn_spline. See for spline interpolation utilized splineInterpolateMonthlytoDailyforSeveralYears.
Tx_spline_sim	daily timeseries (from the first day of year_min_sim to the last day of year_max_sim) of averaged maximum temperature which can be obtained by a spline interpolation of monthly mean values (for the generation period). Default is Tx_spline. See for spline interpolation utilized splineInterpolateMonthlytoDailyforSeveralYears.
onlygeneration	logical variable. If TRUE the VAR model varmodel is given as input and only random generation is done, otherwise (default) is calculated from measured data

varmodel — the comprehensinve VAR model as a varest2 or GPCAvarest2 S4 object or a NULL object. If NULL (default), the comprehensinve VAR is estimated from measured data within the function, otherwise it is given as input and only random generation is done.

normalize, sample, extremes — see normalizeGaussian_severalstations or setComprehensiveTemperatureGeneratorParameters

type_quantile — see type on quantile

option — integer value. If 1, the generator works with minimun and maximum temperature, if 2 (default) it works with the average value between maximum and minimum temparature and the respective daily thermal range.

yearly — logical value. If TRUE the monthly mean values are calculated for each year from year_min to year_max separately. Default is FALSE.

yearly_sim — logical value. If TRUE the monthly mean values are calculated for each year from year_min_sim to year_max_sim separately. Default is yearly.

n_GPCA_iteration — number of iterations of Gaussianization process for data. Default is 0 (no Gaussianization)

n_GPCA_iteration_residuals — number of iterations of Gaussianization process for VAR residuals. Default is 0 (no Gaussianization)

exogen — data frame or matrix containing the (normalized or not) exogenous variables (predictors) for the recorded (calibration) period. Default is NULL.

exogen_sim — data frame or matrix containing the (normalized or not) exogenous variables (predictors) for the simulation period. Default is NULL. If it is NULL, exogen_sim is set equal to exogen within the function.

is_exogen_gaussian — logical value, If TRUE, exogen_sim and exogen are given as already normalized variables, otherwhise they are not normalized. Default is FALSE

exogen_all — data frame containing exogenous variable formatted like Tx_all and Tn_all. Default is NULL. It is alternative to exogen and if it not NULL,is_exogen_gaussian is automatically set to FALSE

exogen_all_col — vector of considered columns of exogen_all. Default is station.

nscenario — number of generated scenarios for daily maximum and minimum temperature

seed — seed for stochastic random generation see set.seed

noise — stochastic noise to add for variabile generation. Default is NULL. See newVARmultieventRealization. Not used in case that nscenario>1.

nearPD — logical. Default is FALSE. See getVARmodel.

Value

A list of the following variables:

input list of variables returned by setComprehensiveTemperatureGeneratorParameters

var varest object containing the used VAR model (if useVAR is true), NULL (otherwise)

output list variables returned by generateTemperatureTimeseries (i.e. generated timeseries)

Note

It pre-processes series and generates multi-site temperature fields by using setComprehensiveTemperatureGeneratorPara
and generateTemperatureTimeseries. Detailed examples can be viewed of this function in this
presentation.

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

setComprehensiveTemperatureGeneratorParameters, generateTemperatureTimeseries ,generateTemperatureTim

Examples

```
data(trentino)

set.seed(1222) # set the seed for random generations!
year_min <- 1961
year_max <- 1990

year_min_sim <- 1982
year_max_sim <- 1983

n_GPCA_iter <- 5
n_GPCA_iteration_residuals <- 5
p <- 1
vstation <- c("B2440","B6130","B8570","B9100","LAVIO","POLSA","SMICH","T0001",
 "T0010","T0014","T0018","T0032","T0064","T0083","T0090","T0092",
"T0094","T0099","T0102","T0110","T0129","T0139","T0147","T0149",
"T0152","T0157","T0168","T0179","T0189","T0193","T0204","T0210",
"T0211","T0327","T0367","T0373")
## Not Run: the call to ComprehensiveTemperatureGenerator may elapse
## too long time (more than 5 eseconds) and is not executed  by CRAN check.
## Please uncomment the following line to run the example on your own PC.
# generation00 <-ComprehensiveTemperatureGenerator(station=vstation[16],
# Tx_all=TEMPERATURE_MAX,Tn_all=TEMPERATURE_MIN,year_min=year_min,year_max=year_max,
# p=p,n_GPCA_iteration=n_GPCA_iter,n_GPCA_iteration_residuals=n_GPCA_iteration_residuals,
# sample="monthly",year_min_sim=year_min_sim,year_max_sim=year_max_sim)
```

`continuity_ratio` *Calculates the continuity ratio of a set of precipitation measured or generated data in several sites as defined by Wilks, 1998 (see reference link)*

Description

Calculates the continuity ratio of a set of precipitation measured or generated data in several sites as defined by Wilks, 1998 (see reference link)

Usage

```
continuity_ratio(data, lag = 0, valmin = 0.5)
```

Arguments

`data`	containing daily precipitation time series for several gauges (one gauge time series per column)
`lag`	numeric lag (expressed as number of days) used for computation for "cross" continuity ratio and joint probability of prercipitation (no)occurrence.
`valmin`	threshold precipitation value [mm] for wet/dry day indicator. If precipitation is lower than `valmin`, day is considered dry. Default is 0.5 mm.

Value

A list containing the following matrices:

`continuity_ratio` : `lag`-day lagged continuity ratio ,

`occurrence` : joint probability of `lag`-day lagged precipitation occurrence

`nooccurrence` : joint probability of `lag`-day lagged no precipitation occurrence.

`nooccurrence_occurrence` : joint probability of `lag`-day lagged no precipitation and precipitation occurrence respectively.

`occurrence_nooccurrence` : joint probability of `lag`-day lagged precipitation and no precipitation occurrence respectively.

`probability_continuity_ratio`: `lag`-day lagged ratio about precipitation probability contitioned to no precipitation/preciitation occurrence in the other site

Note

If `lag==0` the function returns the continuity ratio and joint probability as described by Wilks, 1998. Otherwise the precipitation values for each couple of rain gauges are taken with `lag`-day lag.

References

Mhanna, M. and Bauwens, W. (2012), A stochastic space-time model for the generation of daily rainfall in the Gaza Strip. Int. J. Climatol., 32: 1098-1112. doi:10.1002/joc.2305

D.S. Wilks (1998),Multisite generalization of a daily stochastic precipitation generation model,Journal of Hydrology, doi:10.1016/S00221694(98)001863

Examples

```
data(trentino)

year_min <- 1961
year_max <- 1990
origin <- paste(year_min,1,1,sep="-")

period <- PRECIPITATION$year>=year_min & PRECIPITATION$year<=year_max
station <- names(PRECIPITATION)[!(names(PRECIPITATION) %in% c("day","month","year"))]
prec_mes <- PRECIPITATION[period,station]

## removing nonworking stations (e.g. time series with NA)
accepted <- array(TRUE,length(names(prec_mes)))
names(accepted) <- names(prec_mes)
for (it in names(prec_mes)) {
 accepted[it]  <- (length(which(!is.na(prec_mes[,it])))==length(prec_mes[,it]))
}

prec_mes <- prec_mes[,accepted]
## the dateset is reduced!!!
prec_mes <- prec_mes[,1:2]

continuity_ratio <-continuity_ratio(data=prec_mes,lag=0,valmin=0.5)
continuity_ratio1 <-continuity_ratio(data=prec_mes,lag=-1,valmin=0.5)
```

---

countNAs *counts NAs in each row of* data

Description

counts NAs in each row of data

Usage

```
countNAs(data)
```

Arguments

data	a data input matrix
	@export

Value

the vector with numbers of NA values for each data column

covariance *Calculates the covariance matrix of the normally standardized variables obtained from the columns of* x

Description

Calculates the covariance matrix of the normally standardized variables obtained from the columns of x

Usage

```
covariance(
  x,
  data = x,
  cpf = NULL,
  mean = 0,
  sd = 1,
  step = NULL,
  prec = 10^-4,
  use = "pairwise.complete.obs",
  type = 3,
  extremes = TRUE,
  sample = NULL,
  origin_x = NULL,
  origin_data = origin_x
)
```

Arguments

x	variable
data	a sample of data on which a non-parametric pghjjrobability distribution is estimated
cpf	cumulative probability distribution. If NULL (default) is calculated as ecdf(data)
mean	mean (expected value) of the normalized random variable. Default is 0.
sd	standard deviation of the normalized random variable. Default is 1.
step	vector of values in which step discontinuities of the cumulative probability function occur. Default is NULL
prec	amplitude of the neighbourhood of the step discontinuities where cumulative probability function is treated as non continuous.
use	see cov
type	see quantile
extremes	logical variable. If TRUE (default) the probability or frequency is multiplied by $$\frac{N}{N+1}$$ where N is the length of data

sample	information about sample or probability distribution. Default is NULL
origin_x	date corresponding to the first row of x
origin_data	date corresponding to the first row of data

Value

a matrix with the normalized variable or its inverse

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

normalizeGaussian_severalstations,normalizeGaussian

@note It applies normalizeGaussian_severalstations to x and data and then calculates the covariances among the column. See the R code for further details

---

ElevationOf *Extracts the elevation of a meteorological station expressed in meters above a reference (sea level)*

Description

Extracts the elevation of a meteorological station expressed in meters above a reference (sea level)

Usage

```
ElevationOf(name, station_names, elevation)
```

Arguments

name	character ID of the station
station_names	vector of the IDs (characters) of the considered meteorological stations. An example is STATION_NAMES, which is defined in the trentino dataset.
elevation	vector of the elevation of the considered meteorological stations. An example is ELEVATION, which is defined in the trentino dataset.

Value

the elevation given the vectors of station IDs and the respective elevations

Examples

```
data(trentino)
ElevationOf("T0099",station_names=STATION_NAMES,elevation=ELEVATION)
```

`extractdays` *Extracts the rows of a matrix corresponding to the requested days (expressed as dates YYYY-MM-DD) given the date (origin) of the first row*

Description

Extracts the rows of a matrix corresponding to the requested days (expressed as dates YYYY-MM-DD) given the date (origin) of the first row

Usage

```
extractdays(
  data = array(1:ndim_max, dim = c(ndim_max, 1)),
  ndim_max = 1e+05,
  when = "1990-1-1",
  origin = "1961-1-1",
  nday = 1
)
```

Arguments

`data`	an input data matrix where each row corresponds to a daily record
`ndim_max`	maximum (integer) number of rows in `data` where to find `when`. Default is 100000 and works if `data` is missing.
`when`	desired dates for which the data are requested
`origin`	date corresponding to the first row of `data`
`nday`	(optional) number of days since `when` to extract the data

Value

a matrix containing the requested rows

Note

It uses `julian`

Examples

```
extractdays()
```

`extractmonths` *Extracts the rows of a matrix corresponding to requested months of a year given the date (origin) of the first row*

Description

Extracts the rows of a matrix corresponding to requested months of a year given the date (origin) of the first row

Usage

```
extractmonths(
  data = array(1:ndim_max, dim = c(ndim_max, 1)),
  ndim_max = 1e+05,
  when = c("Dec", "Jan", "Feb"),
  year = NULL,
  origin = "1961-1-1"
)
```

Arguments

`data`	an input data matrix where each row corresponds to a daily record
`ndim_max`	maximum (integer) number of rows in `data` where to find `when`. Default is 100000 and works if `data` is missing.
`when`	character vactor of months for which the data are required. It must be a subset of `c("Jan","Feb","Mar","Apr","May","Jun","Jul","Aug","Sep","Oct","Nov","Dec")`
`year`	year(s) when data must be extracted
`origin`	date corresponding to the first row of `data`

Value

a matrix containing the requested rows

Note

It uses `months` and `julian`

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

`extractdays`

Examples

```
extractmonths()

data(trentino)
dates <- sprintf("%02d-%02d-%02d",TEMPERATURE_MAX$year,TEMPERATURE_MAX$month,TEMPERATURE_MAX$day)
origin <- dates[1]
out <- extractmonths(data=TEMPERATURE_MAX,origin=origin)
```

`extractTnFromAnomalies` *Extracts generated time series of Daily Minimum Temperature from a random multi-realization obtained by* `generateTemperatureTimeseries` *function*

Description

Extracts generated time series of Daily Minimum Temperature from a random multi-realization obtained by `generateTemperatureTimeseries` function

Usage

```
extractTnFromAnomalies(res_multigen, std, SplineAdv)
```

Arguments

`res_multigen`	matrix containing standardized values of daily temperature as returned by `generateTemperatureTimeser` (first item)
`std`	vector containing standard deviation for each minimun temperature anomalies
`SplineAdv`	matrix containing the averaged daily values of minimum temperature obtained by a spline interpolation of the monthly climate

Value

a matrix with generated minimum temperature

Author(s)

Emanuele Cordano, Emanuele Eccel

`extractTxFromAnomalies` *Extracts generated time series of Daily Maximum Temperature from a random multi-realization obtained by* `generateTemperatureTimeseries` *function*

Description

Extracts generated time series of Daily Maximum Temperature from a random multi-realization obtained by `generateTemperatureTimeseries` function

Usage

```
extractTxFromAnomalies(res_multigen, std, SplineAdv)
```

Arguments

`res_multigen`	matrix containing standardized values of daily temperature as returned by `generateTemperatureTimeser` (first item)
`std`	vector containing standard deviation for each maximum temperature anomalies
`SplineAdv`	matrix containing the averaged values of maximum temperature obtained by a spline interpolation of monthly climate

Value

a matrix with generated maximum temperature

Author(s)

Emanuele Cordano, Emanuele Eccel

`extractyears` *Extracts the elements of a data frame corresponding to a period between* `year_min` *and* `year_max` *for the stations listed in* `station`

Description

Extracts the elements of a data frame corresponding to a period between `year_min` and `year_max` for the stations listed in `station`

Usage

```
extractyears(
  data,
  year_min = 1961,
  year_max = 1990,
  station = c("T0001", "T0014", "T0129")
)
```

Arguments

data	a dataframe containing daily data.
year_min	start year
year_max	end year
station	character vector of the IDs of the station where the data are required

Value

a matrix containing the requested daily data where each day corresponds to a row and each station corresponds to a column

Note

The input data frame data must have the following fields: year,month,day,variables_ID1,variables_ID2,... where the fields ,variables_ID1,variables_ID2,... contain the daily variables referred to the respective stations and the field names are replaced with the respective station ID.

---

findDate *Finds the date corresponding a row index of a matrix given the date (origin) of the first row*

Description

Finds the date corresponding a row index of a matrix given the date (origin) of the first row

Usage

```
findDate(
  k,
  origin = "1961-1-1",
  data.frame = TRUE,
  decimal = FALSE,
  character = FALSE
)
```

Arguments

k	integer or decimal value corresponding to number of days since origin
origin	origin date. See also extractdays
data.frame	logical variable. If TRUE (default) the date is returned as data frame (like data in extractyears), otherwise it is returned as character or POSIXct.
decimal	logical variable. If FALSE (default) k is integer and starts from 1, otherwise is consider as the decimal julian day since origin (deprecated)
character	logical variable. It is used if data.frame is FALSE, if it is FALSE, the date is returned as POSIXct, otherwise it is a character in the following form: YYYY-MM-DD

Value

the date(s) corresponding to k under different formats

Note

It uses functions of time package. It works like an inverse functions of extractdays. If k is a vector, the function returns several dates for each element of k

See Also

date.mdy,extractdays

Examples

```
findDate <- findDate(100,origin="1961-1-1",data.frame=FALSE,character=TRUE)
```

---

forecastEV — *Forecasts the expected value of a VAR realization given the prievious one*

Description

Forecasts the expected value of a VAR realization given the prievious one

Usage

```
forecastEV(var, xprev = NULL, exogen = NULL)
```

Arguments

var	A VAR model represented by a varest object as returned by getVARmodel or VAR
xprev	previous status of the random variable
exogen	vector containing the values of the "exogen" variables (predictor) for the generation

Value

a vector of values

See Also

forecastResidual

@export

`forecastResidual` *Forecasts the residual value of a VAR realization given the white noise covariance matrix*

Description

Forecasts the residual value of a VAR realization given the white noise covariance matrix

Usage

```
forecastResidual(var, xprev = NULL, B = NULL)
```

Arguments

`var`	A VAR model represented by a `varest` object as returned by `getVARmodel` or `VAR`
`xprev`	previous status of the random variable, in this case the "current instant"white-noise". Default is `NULL` and then randomly generated.
`B`	matrix of coefficients for the vectorial white-noise component

Value

a vector of values

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

`forecastEV`,`NewVAReventRealization`

generateTemperatureTimeseries

Returns time series of Daily Maximum and Minimum with a random multi-realization obtained by using newVARmultieventRealization. *This function is called by* ComprehensiveTemperatureGenerator.

Description

Returns time series of Daily Maximum and Minimum with a random multi-realization obtained by using newVARmultieventRealization. This function is called by ComprehensiveTemperatureGenerator.

Usage

```
generateTemperatureTimeseries(
  std_tn,
  std_tx,
  SplineTx,
  SplineTn,
  SplineTm,
  SplineDeltaT,
  std_tm,
  var = NULL,
  exogen = NULL,
  normalize = TRUE,
  type = 3,
  extremes = TRUE,
  sample = NULL,
  option = 1,
  original_data,
  origin_x = NULL,
  origin_data = NULL,
  noise = NULL
)
```

Arguments

std_tn	vector containing standard deviation of daily minimum temperature anomalies. stdTn is default, see setComprehensiveTemperatureGeneratorParameters.
std_tx	vector containing standard deviation of daily maximum temperature anomalies. stdTx is default, see setComprehensiveTemperatureGeneratorParameters.
SplineTx	matrix containing the averaged daily maximum temperature obtained by a spline interpolation of monthly means . SplineAdvTx is default, see setComprehensiveTemperatureGenerato
SplineTn	matrix containing the averaged daily minimum temperature obtained by a spline interpolation of monthly means . SplineAdvTn is default, see setComprehensiveTemperatureGenerato
SplineTm	matrix containing the averaged daily "mean" temperature obtained by a spline interpolation of monthly means . SplineAdvTm is default, see setComprehensiveTemperatureGenerato

SplineDeltaT	matrix containing the rescaled averaged daily temperature range obtained by a spline interpolation of monthly means. SplineAdvDelta_T_sim/SplineAdvDelta_T is default, see setComprehensiveTemperatureGeneratorParameters.
std_tm	vector containing standard deviation of daily "mean" temperature anomalies. stdTn is default, see setComprehensiveTemperatureGeneratorParameters.
var	A VAR model represented by a varest object as returned by getVARmodel or VAR
exogen	see VAR
normalize	logical variable If TRUE normalizeGaussian_severalstations is used, otherwise not. If option is 2, it is always TRUE.
type	see quantile
sample, origin_x, origin_data, extremes	see normalizeGaussian_severalstations
option	integer value. If 1, the generator works with minimum and maximum temperature, if 2 (Default) it works with th average value between maximum and minimum temparature and the respective daily Thermal Range.
original_data	matrix containing the measured standardized temperature anomalies
noise	stochastic noise to add for variabile generation. Default is NULL. See newVARmultieventRealization.

Value

This function returns a list of the following variables:

res_multigen matrix containing standardized values of daily maximum and minimum temperature anomalies

Tx_spline matrix containing climatic "spline-interpolated" daily maximum temperature

Tn_spine matrix containing climatic "spline-interpolated" daily minimum temperature

Tx_gen matrix containing generated daily maximum daily temperature (Tx_{gen})

Tn_gen matrix containing generated daily minimum daily temperature (Tn_{gen})

Tm_gen matrix containing generated "mean" daily temperature defined as $\frac{Tx_{gen}+Tn_{gen}}{2}$

DeltaT_gen matrix containing generated daily thermal range defined as $Tx_{gen} - Tn_{gen}$

See the R code for further details

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

newVARmultieventRealization,normalizeGaussian_severalstations

getDailyMean *Calculates the daily means of a range of days around each date of a data frame corresponding to a period between* year_min *and* year_max *for stations listed in* station

Description

Calculates the daily means of a range of days around each date of a data frame corresponding to a period between year_min and year_max for stations listed in station

Usage

```
getDailyMean(
  data,
  year_min = 1961,
  year_max = 1990,
  station = c("T0001", "T0010"),
  origin = "1961-1-1",
  lag = 5
)
```

Arguments

data	a data frame containing daily data.
year_min	start year
year_max	end year
station	character vector of the IDs of the station where the data are requested
origin	origin date of time-series
lag	lag (number of days) on which daily mean is calculated. The mean is calculated considereing lag days before and after each day.

Value

a matrix containing the requested daily mean data where each day corresponds to a row and each station corresponds to a column

Note

The input data frame data must have the following fields: year,month,day,variables_ID1,variables_ID2,... where the fields ,variables_ID1,variables_ID2,... contain the daily variables referred to the respective stations and the field names are replaced with the respective station ID.

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

extractyears

`getMonthlyMean` *Calculates the monthly means of a data frame corresponding to a period between* `year_min` *and* `year_max` *for stations listed in* `station`

Description

@author Emanuele Cordano, Emanuele Eccel

Usage

```
getMonthlyMean(
  data,
  year_min = 1961,
  year_max = 1990,
  station = names(data),
  no_date = FALSE,
  origin = "1961-1-1",
  yearly = FALSE
)
```

Arguments

`data`	a dataframe containing daily data.
`year_min`	start year
`year_max`	end year
`station`	character vector of the IDs of the station where the data are requested
`no_date`	logical value if `TRUE` the function `extractmonths` is used. Default is `FALSE`. It is recommended if `data` does not contain columns for the dates.
`origin`	date corresponding to the first row
`yearly`	logical value. If `TRUE` the monthly mean values are calculated for each year from `year_min` to `year_max` separately. Default is `FALSE`.

Value

a matrix containing the requested monthly means where each month corresponds to a row and each station corresponds to a column or a list of such matrices in case the monthly mean values are calculated separately for each year (if `yearly` is `TRUE`)

Note

The input data frame `data` must have the following fields: `year,month,day,variables_ID1,variables_ID2,...` where the fields `,variables_ID1,variables_ID2,...` contain the daily variables referred to the respective stations and the field names are replaced with the respective station ID. In case `yearly` is `TRUE` the returned output is a list of matrices whose names are the corresponding year.

See Also

extractyears

---

getVARmodel *Either creates a VAR model or chooses a VAR model by using VAR or VARselect commands of* vars *package*

Description

Either creates a VAR model or chooses a VAR model by using VAR or VARselect commands of vars package

Usage

```
getVARmodel(
  data,
  suffix = c("_Tx", "_Tn"),
  sep = "",
  p = 1,
  type = "none",
  season = NULL,
  exogen = NULL,
  lag.max = NULL,
  ic = "AIC",
  activateVARselect = FALSE,
  na.rm = TRUE,
  n_GPCA_iteration = 0,
  n_GPCA_iteration_residuals = n_GPCA_iteration,
  extremes = TRUE,
  nearPD = FALSE
)
```

Arguments

data	see VAR and addsuffixes
suffix	see addsuffixes
sep	separator element. See addsuffixes).
p	lag considered for the auto-regression see VAR
type	see VAR
season	see VAR
exogen	see VAR
lag.max	see VARselect
ic	see VAR

activateVARselect
: logical variables. If TRUE, the function VARselect is run. Default and recommended use is FALSE.

na.rm
: logical variables. If TRUE (default), it takes into account NA values

n_GPCA_iteration
: number of iterations of Gaussianization process for data. Default is 0 (no Gaussianization)

n_GPCA_iteration_residuals
: number of iterations of Gaussianization process for data. Default is 0 (no Gaussianization)

extremes
: see normalizeGaussian_severalstations and GPCA

nearPD
: logical (experimental) and passed to GPCA. Default is FALSE. If TRUE covariance matrix is corrected through Nearest Positive Definite Matrix procedure, i.e. nearPD

Value

a varest2 or GPCAvarest2 object representing a VAR model or a GPCA-varest object which also contains the GPCA transformation parameters

Note

It inherits input parameters of VAR, VARselect and addsuffixes. The variable data contains the measured data on which the vector auto-regressive models is estimated. It is a matrix where each row is a realization of the vector random variable. In some application of this package, the random variables may be the daily maximum and minimum temperature anomalies for different stations. Often the the columns of data are called with the IDs of the stations whithout specifying the type of variable (e.g. minimun or maximum temperature anomalies). This means that two or more columns may have the same name. Therefore the function addsuffixes, which is called from this function, adds suitable suffixes to the column names.

Author(s)

Emanuele Cordano, Emanuele Eccel

Examples

```
set.seed(122)
NSTEP <- 1000
x <- rnorm(NSTEP)
y <- x+rnorm(NSTEP)
z <- c(rnorm(1),y[-1]+rnorm(NSTEP-1))
df <- data.frame(x=x,y=y,z=z)

exogen <- as.data.frame(x+5)
only_var <- VAR(df,type="none")

gpcavar <- getVARmodel(data=df,suffix=NULL,p=3,n_GPCA_iteration=5,
                       n_GPCA_iteration_residuals=5,exogen=exogen)
```

```
exogen <- as.data.frame(x+5)

data_for_var <- gpcavar@GPCA_data$final_results

data(collinear_dataset)
gpcavar_coll <- getVARmodel(data=collinear_dataset,suffix=NULL,p=3,n_GPCA_iteration=5,
                n_GPCA_iteration_residuals=0,exogen=NULL,nearPD=TRUE) ## use nearPD==TRUE
```

GPCA *This function makes a Gaussianization procedure based on PCA iteration (see GPCA_iteration)*

Description

This function makes a Gaussianization procedure based on PCA iteration (see GPCA_iteration)

Usage

```
GPCA(x_prev, n = 30, extremes = TRUE, nearPD = FALSE)
```

Arguments

x_prev	previous set of the random variable x. If it is a varest object, the residuals are taken into account.
n	number of reiterations
extremes	see normalizeGaussian_severalstations
nearPD	logical. Default is FALSE. If TRUE covariance matrix is corrected through Nearest Positive Definite Matrix procedure, i.e. nearPD

Value

A GPCA-class S3 object returned by GPCA_iteration at each iteration and the final results of the G-PCA procedure (matrix final_results)

Note

This function re-iterates the equation (1) of "PCA Gaussianization for One-Class Remote Sensing Image" by V. Laparra et al., https://www.uv.es/lapeva/papers/SPIE09_one_class.pdf,https://www.uv.es/vista/vistavalencia/papers/SPIE_09_Gaussianization_presentation.pdf

Author(s)

Emanuele Cordano

See Also

GPCA,GPCA_iteration,inv_GPCA_iteration,inv_GPCA,GPCA-class for 'GPCA' S3 class

Examples

```
library(RMAWGEN)
set.seed(1222)
nIterations <- 30
N <- 20
x <- rexp(N)
y <- x+rnorm(N)
df <- data.frame(x=x,y=y)

GPCA <- GPCA(df,n=nIterations,extremes=TRUE)

x <- rnorm(N)
y <- x+rnorm(N)
dfn <- data.frame(x=x,y=y)

GPCAn <- GPCA(dfn,n=nIterations,extremes=TRUE)
```

GPCA-class *GPCA-class*

Description

GPCA S3 class returned by GPCA

Details

list of GPCA_iteration subsequent GPCA iterations

final_results data.frame or matrix of the "gaussianized" data

Note

Formal definition with setOldClass for the S3 class GPCA

Author(s)

Emanuele Cordano

Examples

```
showClass("GPCA")
```

GPCAiteration-class *GPCAiteration-class*

Description

GPCAiteration S3 class returned by GPCA_iteration

Details

x_prev Previous set of random variable, x_prev input variable of GPCA_iteration

x_gauss_prev Marginal Gaussianization of x_prev obtained through normalizeGaussian_severalstations

B_prev rotation matrix (i. e. eigenvector matrix of the covariance matrix of x_gauss_prev)

x_next results obtained by multiplying B_prev by x_gauss_prev (see equation 1 of the reference in GPCA_iteration)

Note

Formal definition with setOldClass for the S3 class GPCAiteration

Author(s)

Emanuele Cordano

Examples

```
showClass("GPCAiteration")
```

GPCAvarest2-class *GPCAvarest2-class*

Description

This class inherits varest2 and contains all information about GPCA (GPCA transformation.

Details

GPCA_data: A "GPCA" S3 object containing the parameters of the Multi-variate Gaussianization of the time series, it is the result of GPCA function applied to the input data of getVARmodel

GPCA_residuals: A "GPCA" S3 object containing the parameters of the Multi-variate Gaussianization of the residuals of the VAR model contained in the VAR slot; it is NULL if no Gaussiatization of residuals is applied. Object of class "list"

VAR: S3 Object of class "varest"

#' @note A GPCAvarest2 object can be created by new("GPCAvarest2", ...) or returned by the function getVARmodel

Author(s)

Emanuele Cordano

Examples

```
showClass("GPCAvarest2")
```

`GPCA_iteration` *This function makes an iteration of PCA-Gaussianization process*

Description

This function makes an iteration of PCA-Gaussianization process

Usage

```
GPCA_iteration(x_prev, extremes = TRUE, nearPD = FALSE)
```

Arguments

`x_prev`	previous set of random variable `x`
`extremes`	see `normalizeGaussian_severalstations`
`nearPD`	logical. Default is `FALSE`. If `TRUE` covariance matrix is corrected through Nearest Positive Definite Matrix procedure, i.e. `nearPD`

Value

A `GPCA_iteration` S3 object which contains the following objects:

`x_prev` Previous set of random variable, `x_prev` input variable

`x_gauss_prev` Marginal Gaussianization of `x_prev` obtained through `normalizeGaussian_severalstations`

`B_prev` rotation matrix (i. e. eigenvector matrix of the covariance matrix of `x_gauss_prev`

`x_next` results obtained by multiplying `B_prev` by `x_gauss_prev` (see equation 1 of the reference)

Note

This function is based on equation (1) of "PCA Gaussianization for One-Class Remote Sensing Image" by V. Laparra et al., https://www.uv.es/lapeva/papers/SPIE09_one_class.pdf and https://ieeexplore.ieee.org/document/5413808/

Author(s)

Emanuele Cordano

See Also

`GPCA`,`GPCA_iteration`,`inv_GPCA_iteration`,`inv_GPCA`

Examples

```
library(RMAWGEN)
set.seed(1222)
N <- 20
x <- rexp(N)
y <- x+rnorm(N)
df <- data.frame(x=x,y=y)

GPCA <- GPCA_iteration(df,extremes=TRUE)

x <- rnorm(N)
y <- x+rnorm(N)
dfn <- data.frame(x=x,y=y)

GPCAn <- GPCA_iteration(dfn,extremes=TRUE)
```

`inv_GPCA` *This function makes an inverse Gaussianization procedure besad on PCA iteration (see* `inv_GPCA_iteration`

Description

This function makes an inverse Gaussianization procedure besad on PCA iteration (see `inv_GPCA_iteration`

Usage

```
inv_GPCA(x = NULL, GPCA_param, type = 3, extremes = TRUE)
```

Arguments

`x`	gaussian random variable to transform
`GPCA_param`	`GPCA-class` S3 object returned by the function `GPCA`
`type`	see `normalizeGaussian_severalstations`
`extremes`	see `normalizeGaussian_severalstations`

Value

the non-Gaussian random variable

Note

This function re-iterates the inverse of equation (1) of "PCA Gaussianization for One-Class Remote Sensing Image" by V. Laparra et al., https://ieeexplore.ieee.org/document/5413808/

Author(s)

Emanuele Cordano

See Also

GPCA,GPCA_iteration,inv_GPCA_iteration,inv_GPCA

Examples

```
library(RMAWGEN)
set.seed(1222)
nIterations <- 30
N <- 20
x <- rexp(N)
y <- x+rnorm(N)
df <- data.frame(x=x,y=y)

GPCA <- GPCA(df,n=nIterations,extremes=TRUE)

x <- rnorm(N)
y <- x+rnorm(N)
dfn <- data.frame(x=x,y=y)

GPCAn <- GPCA(dfn,n=nIterations,extremes=TRUE)

df_out <- inv_GPCA(GPCA_param=GPCA,extremes=TRUE)
dfn_out <- inv_GPCA(GPCA_param=GPCAn,extremes=TRUE)
```

---

inv_GPCA_iteration *This function makes an inverse iteration of PCA-Gaussianization process*

Description

This function makes an inverse iteration of PCA-Gaussianization process

Usage

```
inv_GPCA_iteration(
  x = GPCA_iter_param$x_next,
  GPCA_iter_param,
  type = 3,
  extremes = TRUE
)
```

Arguments

x	matrix of gaussian random variale to transform
GPCA_iter_param	GPCAiteration S3 object returned by the function GPCA_iteration corresponding the related direct iteration
type	see normalizeGaussian_severalstations
extremes	see normalizeGaussian_severalstations

Value

the non-Gaussian random variable

Note

This function is based on the inverse of the equation (1) of "PCA Gaussianization for One-Class Remote Sensing Image" by V. Laparra et al., https://ieeexplore.ieee.org/document/5413808/

See Also

GPCA,GPCA_iteration,inv_GPCA_iteration,inv_GPCA,GPCA-class for 'GPCA' S3 class

Examples

```
library(RMAWGEN)
set.seed(1222)
N <- 20
x <- rexp(N)
y <- x+rnorm(N)
df <- data.frame(x=x,y=y)

GPCA <- GPCA_iteration(df,extremes=TRUE)

x <- rnorm(N)
y <- x+rnorm(N)
dfn <- data.frame(x=x,y=y)

GPCAn <- GPCA_iteration(dfn,extremes=TRUE)

df_out <- inv_GPCA_iteration(GPCA_iter_param=GPCA,extremes=TRUE)
dfn_out <- inv_GPCA_iteration(GPCA_iter_param=GPCAn,extremes=TRUE)
```

is.monthly.climate	*Verifies if 'climate' represents the monthly climatology in one year, i.e 'climate' is monthly.climate type matrix whose rows represent months and each column represents a station. It is also used in* setComprehensiveTemperatureGeneratorParameters.

Description

Verifies if 'climate' represents the monthly climatology in one year, i.e 'climate' is monthly.climate type matrix whose rows represent months and each column represents a station. It is also used in setComprehensiveTemperatureGeneratorParameters.

Usage

```
is.monthly.climate(climate, nstation = 3, nmonth = 12, verbose = TRUE)
```

Arguments

climate	matrix containing the 'monthly climatology' data
nstation	number of variable measurement stations (columns of the matrix 'climate')
nmonth	number of months in one year (it can be different if climate is represented by seasonal avarages or others), Default is 12 (recommended). (it can be different if climate is represented by seasonal averages, in this case 4)
verbose	Prints output and warining messagrs only if is TRUE.

Value

A logical variable if the matrix 'climate' is monthly.climate type

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

setComprehensiveTemperatureGeneratorParameters

months_f *months REPLACEMANT*

Description

months REPLACEMANT

Usage

```
months_f(x, ...)
```

Arguments

x	an object. See months
...	arguments

NewVAReventRealization *Generates a new realization of a VAR model*

Description

Generates a new realization of a VAR model

Usage

```
NewVAReventRealization(var, xprev, noise, exogen = NULL, B = NULL)
```

Arguments

var	A VAR model represented by a varest object as returned by getVARmodel or VAR
xprev	previous status of the random variable
noise	uncorrelated or white noise (residual). Default is rnorm(length(xprev)) (or rnorm(ncol(B))
exogen	vector containing the values of the "exogen" variables (predictor) for the generation
B	matrix of coefficients for the vectorial white-noise component

Value

a vector of values

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

forecastEV,forecastResidual

---

newVARmultieventRealization

Generates several realizations of a VAR model

Description

Generates several realizations of a VAR model

Usage

```
newVARmultieventRealization(
  var,
  xprev = rnorm(var@VAR$K * var@VAR$p),
  exogen = NULL,
  nrealization = 10,
  B = t(chol(cov(residuals(var)))),
  extremes = TRUE,
  type = 3,
  noise = NULL
)
```

Arguments

var	A VAR model represented by a varest2 object as returned by getVARmodel
xprev	previous status of the random variable
exogen	matrix containing the values of the "exogen" variables (predictor) for the generation
nrealization	number of realization (e.g. days to simulate). If exogen is not NULL and it is a matrix, it must be lower or equal to the number of rows of exogen
B	matrix of coefficients for the vector white-noise component
extremes, type	see inv_GPCA
noise	stochastic noise to add for variabile generation. Default is NULL and it is automatically randomly genereted accordind to matrix B. If the VAR model (var argument) does not fit well the residuals (e.g. non-normality, non-serialty or heteroskesticity) and the white noise is manually inserted, in this case argument B is not taken into account.

Value

a matrix of values

Author(s)

Emanuele Cordano, Emanuele Eccel

`normality_test` `normality.test` *method for* `varest2` *object*

Description

`normality.test` method for `varest2` object

Usage

```
normality_test(object, ...)
```

Arguments

`object`	a `varest2` object
`...`	passed arguments

See Also

`normality.test`

`normalizeGaussian` *Converts a random variable* `x` *extracted by a population represented by the sample* `data` *or* `sample` *to a normally-distributed variable with assigned mean and standard deviation or vice versa in case* `inverse` *is* TRUE

Description

Converts a random variable `x` extracted by a population represented by the sample `data` or `sample` to a normally-distributed variable with assigned mean and standard deviation or vice versa in case `inverse` is TRUE

Usage

```
normalizeGaussian(
  x = 0,
  data = x,
  cpf = NULL,
  mean = 0,
  sd = 1,
  inverse = FALSE,
  step = NULL,
  prec = 10^-4,
  type = 3,
  extremes = TRUE,
  sample = NULL
)
```

Arguments

x	value or vector of values to be converted
data	a sample of data on which a non-parametric probability distribution is estimated
cpf	cumulative probability distribution. If NULL (default) is calculated as ecdf(data)
mean	mean (expected value) of the normalized random variable. Default is 0.
sd	standard deviation of the normalized random variable. Default is 1.
inverse	logical value. If TRUE the function works inversely (the opposite way). Default is FALSE.
step	vector of values in which step discontinuities of the cumulative probability function occur. Default is NULL
prec	amplitude of the neighbourhood of the step discontinuities where cumulative probability function is treated as non-continuous.
type	see quantile
extremes	logical variable. If TRUE (default) the probability or frequency is multiplied by $$\frac{N}{N+1}$$ where N is the length of data
sample	a character string or NULL containing sample or probability distribution information. Default is NULL

Value

the normalized variable or its inverse

@note This function makes a Marginal Gaussianization. See the R code for further details

Author(s)

Emanuele Cordano, Emanuele Eccel

normalizeGaussian_prec

Converts precipitation values to "Gaussinized" normally-distributed values taking into account the probability of no precipitation occurrences. values or vice versa in case `inverse` *is* `TRUE`

Description

Converts precipitation values to "Gaussinized" normally-distributed values taking into account the probability of no precipitation occurrences. values or vice versa in case `inverse` is `TRUE`

Usage

```
normalizeGaussian_prec(
  x = 0,
  data = x,
  cpf = NULL,
  mean = 0,
  sd = 1,
  inverse = FALSE,
  type = 3,
  extremes = TRUE,
  sample = NULL,
  qnull = 0,
  valmin = 1
)
```

Arguments

`x`	value or vector of values to be converted
`data`	a sample of data on which a non-parametric probability distribution is estimated
`cpf`	cumulative probability distribution. If `NULL` (default) is calculated as `ecdf(data)`
`mean`	mean (expected value) of the normalized random variable. Default is 0.
`sd`	standard deviation of the normalized random variable. Default is 1.
`inverse`	logical value. If `TRUE` the function works inversely (the opposite way). Default is `FALSE`.
`type`	see `quantile`
`extremes`	logical variable. If `TRUE` (default) the probability or frequency is multiplied by $\frac{N}{N+1}$ where N is the length of `data`
`sample`	a character string or `NULL` containing sample or probability distribution information. Default is `NULL`
`qnull`	probability of no precipitation occurrence
`valmin`	minimum value of precipitation to consider a wet day

Value

the normalized variable or its inverse

Note

In the version 1.2.5 of **RMAWGEN** This function is deprecated and not used.

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

normalizeGaussian

Examples

```
library(RMAWGEN)
NDATA <- 1000
occurrence <- as.logical(runif(NDATA)>0.5)
prec <- rexp(NDATA,rate=1/3)
prec[!occurrence] <- 0
valmin <- 0.5 #0.01
x <- normalizeGaussian_prec(x=prec,valmin=valmin)
prec2 <- normalizeGaussian_prec(x=x,data=prec,valmin=valmin,inverse=TRUE)
qqplot(prec,prec2)

occurrence3 <- as.logical(runif(NDATA)>0.5)
prec3 <- rexp(NDATA,rate=1/3)
prec3[!occurrence3] <- 0
x3 <- normalizeGaussian_prec(x=prec3,valmin=valmin)

qqplot(x,x3)
abline(0,1)
```

`normalizeGaussian_severalstations`

Converts several samples `x` *random variable extracted by populations represented by the columns of* `data` *respectively or* `sample` *to a normally-distributed samples with assinged mean and standard deviation or vice versa in case* `inverse` *is* `TRUE`

Description

Converts several samples `x` random variable extracted by populations represented by the columns of `data` respectively or `sample` to a normally-distributed samples with assinged mean and standard deviation or vice versa in case `inverse` is `TRUE`

Usage

```
normalizeGaussian_severalstations(
  x,
  data = x,
  cpf = NULL,
  mean = 0,
  sd = 1,
  inverse = FALSE,
  step = NULL,
  prec = 10^-4,
  type = 3,
  extremes = TRUE,
  sample = NULL,
  origin_x = NULL,
  origin_data = origin_x
)
```

Arguments

x	value to be converted
data	a sample of data on which a non-parametric probability distribution is estimated
cpf	cumulative probability distribution. If NULL (default) is calculated as ecdf(data)
mean	mean (expected value) of the normalized random variable. Default is 0.
sd	standard deviation of the normalized random variable. Default is 1.
inverse	logical value. If TRUE the function works inversely (the opposite way). Default is FALSE.
step	vector of values in which step discontinuities of the cumulative probability function occur. Default is NULL
prec	amplitude of the neighbourhood of the step discontinuities where cumulative probability function is treated as non-continuous.
type	see quantile
extremes	logical variable. If TRUE (default) the probability or frequency is multiplied by $$\frac{N}{N+1}$$ where N is the length of data
sample	information on how to sample x and data. Default is NULL, this means that the values of each column of x and data belong to the same sample. If x and data are sampled for each month seperately, it is set to monthly.
origin_x	date corresponding to the first row of x
origin_data	date corresponding to the first row of data

Value

a matrix with the normalized variable or its inverse

Note

It applies normalizeGaussian for each column of x and data. See the R code for further details

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

normalizeGaussian

Examples

```
## Not run:
library(RMAWGEN)

set.seed(1234)
N <- 30
x <- rexp(N)
y <- x+rnorm(N)
df <- data.frame(x=x,y=y)

dfg <- normalizeGaussian_severalstations(df,data=df,extremes=TRUE,inverse=FALSE)

dfi <- normalizeGaussian_severalstations(dfg,data=df,extremes=TRUE,inverse=TRUE)

N <- 365*2
origin <- "1981-01-01"
x <- rexp(N)
y <- x+rnorm(N)
df <- data.frame(x=x,y=y)

dfgm <- normalizeGaussian_severalstations(df,data=df,extremes=TRUE,
inverse=FALSE,origin_x=origin,origin_data=origin,sample="monthly")

dfim <- normalizeGaussian_severalstations(dfg,data=df,extremes=TRUE,
inverse=TRUE,origin_x=origin,origin_data=origin,sample="monthly")


## Compatibility with 'lubridate' package


library(lubridate)


N <- 30
x <- rexp(N)
y <- x+rnorm(N)
df <- data.frame(x=x,y=y)

dfg <- normalizeGaussian_severalstations(df,data=df,extremes=TRUE,inverse=FALSE)
```

```
dfi <- normalizeGaussian_severalstations(dfg,data=df,extremes=TRUE,inverse=TRUE)

N <- 365*2
origin <- "1981-01-01"
x <- rexp(N)
y <- x+rnorm(N)
df <- data.frame(x=x,y=y)

dfgm <- normalizeGaussian_severalstations(df,data=df,extremes=TRUE,
inverse=FALSE,origin_x=origin,origin_data=origin,sample="monthly")

dfim <- normalizeGaussian_severalstations(dfg,data=df,extremes=TRUE,
inverse=TRUE,origin_x=origin,origin_data=origin,sample="monthly")

## End(Not run)
```

`normalizeGaussian_severalstations_prec`

DEPRECATED Converts several samples `x` *random variable (daily precipitation values) extracted by populations represented by the columns of* `data` *respectively or* `sample` *to a normally-distributed samples with assinged mean and standard deviation or vice versa in case* `inverse` *is* TRUE *using the function* `normalizeGaussian_prec`

Description

DEPRECATED Converts several samples `x` random variable (daily precipitation values) extracted by populations represented by the columns of `data` respectively or `sample` to a normally-distributed samples with assinged mean and standard deviation or vice versa in case `inverse` is TRUE using the function `normalizeGaussian_prec`

Usage

```
normalizeGaussian_severalstations_prec(
  x,
  data = x,
  cpf = NULL,
  mean = 0,
  sd = 1,
  inverse = FALSE,
  qnull = NULL,
  valmin = 0.5,
  type = 3,
  extremes = TRUE,
```

```
  sample = NULL,
  origin_x = NULL,
  origin_data = NULL
)
```

Arguments

x	value to be converted
data	a sample of data on which a non-parametric probability distribution is estimated
cpf	cumulative probability distribution. If NULL (default) is calculated as ecdf(data)
mean	mean (expected value) of the normalized random variable. Default is 0.
sd	standard deviation of the normalized random variable. Default is 1.
inverse	logical value. If TRUE the function works inversely (the opposite way). Default is FALSE.
qnull	probability of no precipitation occurrence. (It can be a matrix in case sample="monthly"
valmin	minimum value of precipitation to consider a wet day
type	see quantile
extremes	logical variable. If TRUE (default) the probability or frequency is multiplied by $$\frac{N}{N+1}$$ where N is the length of data
sample	information about sample or probability distribution. Default is NULL
origin_x	date corresponding to the first row of x
origin_data	date corresponding to the first row of data

Value

a matrix or a data.frame with the normalized variable or its inverse

Note

In the version 1.2.5 of **RMAWGEN** This function is deprecated and not used.

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

normalizeGaussian_prec

`plotDailyClimate` *Plots daily climatology through one year*

Description

Plots daily climatology through one year

Usage

```
plotDailyClimate(
  data,
  title = "Daily_Avereged_Temperture_in_one_year",
  origin = "1961-1-1",
  when = "1979-1-1",
  ylab = "Temperature [degC]",
  xlab = "Time [days]",
  nday = 365,
  bicolor = FALSE,
  col = "black",
  lwd = 1
)
```

Arguments

`data`	matrix whose columns contain daily-averaged climatic series of variables (e.g. maximum or minum daily averaged temperature obtained by spline interpolation of monthly climatology)
`title`, `xlab`, `ylab`, `col`, `lwd`	see `plot.default`
`origin`	origin date corresponding to the first row of `data`
`when`	start day for daily climatology plot
`nday`	number of days in one year. Default is 365.
`bicolor`	logical variable. If `TRUE` and `data` represents climatologies of minimun and maximum daily temperature, the lines are plotted with blue and red colors respectively.

Value

a matrix containing the plotted variables

Author(s)

Emanuele Cordano, Emanuele Eccel

plot_sample *It makes a plot by sampling (e.g. monthly) the variables* x *and* y

Description

It makes a plot by sampling (e.g. monthly) the variables x and y

Usage

```
plot_sample(
  x,
  y = normalizeGaussian_severalstations(x = as.data.frame(x), data = as.data.frame(data),
    origin_x = origin_x, origin_data = origin_data, sample = sample, step = step, prec =
      prec)[, 1],
  xlim = range(x, na.rm = TRUE),
  legend_position = "topleft",
  ylim = range(y, na.rm = TRUE),
  pch = 1,
  col = 1,
  col_max = 0.9,
  col_min = 0.1,
  origin,
  sample = NULL,
  xhist = hist(x, breaks = breaks, plot = FALSE),
  yhist = hist(y, breaks = breaks, plot = FALSE),
  axes = FALSE,
  step = NULL,
  prec = 1e-04,
  breaks = 50,
  origin_x = origin,
  origin_data = origin,
  data = x,
  xlab = "",
  ylab = "",
  color = FALSE,
  gray = TRUE,
  sort = FALSE,
  valmin_x = valmin,
  valmin_y = valmin,
  valmin = -9999,
  abline = c(0, 1),
  ...
)
```

Arguments

x	vector of input data

y	vector of second input data. Default is normalizeGaussian_severalstations(x=as.data.frame(x),c
xlim, ylim, xlab, ylab	see plot.default (Graphic)
legend_position	legend position. Default is "topleft". See legend.
pch	integer single or multi values for pch (see plot.default). Default is 1.
col	integer single or multi values for col (see plot.default). Default is 1.
col_max	maximum value for color scale to apply to rainbow or rainbow. Utilized if col is not a vector and both gray or color are TRUE. Default is 0.9 .
col_min	minimum value for color scale to apply to rainbow or rainbow. Utilized if col is not a vector and both gray or color are TRUE. Default is 0.1 .
origin	date of the first row of x. See normalizeGaussian_severalstations.
sample	string character containg informatio how to sample x and y. Default is NULL. If NULL no sampling is done.see normalizeGaussian_severalstations. Only NULL or "monthly" options are implemented.
xhist	frequency histogram for x. Default is hist(x,breaks=breaks,plot=FALSE). If it is NULL, no marginal histograms appear.
yhist	frequency histogram for y. Default is hist(y,breaks=breaks,plot=FALSE). If it is NULL, no marginal histograms appear. =hist(y,breaks=breaks,plot=FALSE),
axes	see barplot
step, prec	see normalizeGaussian_severalstations
breaks	see hist
origin_x	see normalizeGaussian_severalstations. Default value is set equal to origin.
origin_data	normalizeGaussian_severalstations. Default value is set equal to origin.
data	normalizeGaussian_severalstations. Default value is set equal to x.
color	logical value. If TRUE and if col is unspecified, a color scale is applied according to col_min and col_max (see rainbow). Default is FALSE.
gray	logical value. If TRUE and if col is unspecified, a color scale is applied according to col_min and col_max (see gray). Default is TRUE.
sort	logical value. If TRUE, x and y are sorted and a Q-Q plot is presented. Deafault is FALSE.
valmin_x	numerical threshold value over which the variable x is plotted. It is enabled only if sort is set TRUE.
valmin_y	numerical threshold value over which the variable y is plotted. It is enabled only if sort is set TRUE.
valmin	numerical threshold value for valmin_y and valmin_x if there are not specified.
abline	arguments for abline function. Default is c(0,1). If it is NULL, abline is disabled and not called.
...	see graphical parametes on plot.default @usage plot_sample(x, y = normalizeGaussian_severalstations(x = as.data.frame(x), data = as.data.frame(data), origin_x = origin_x, origin_data = origin_data, sample = sample, step = step, prec = prec)[, 1], xlim = range(x, na.rm = TRUE),

legend_position = "topleft", ylim = range(y, na.rm = TRUE), pch = 1, col = 1, col_max = 0.9, col_min = 0.1, origin, sample = NULL, xhist = hist(x, breaks = breaks, plot = FALSE), yhist = hist(y, breaks = breaks, plot = FALSE), axes = FALSE, step = NULL, prec = 1e-04, breaks = 50, origin_x = origin, origin_data = origin, data = x, xlab = "", ylab = "", color = FALSE, gray = TRUE, sort = FALSE, valmin_x = valmin, valmin_y = valmin, valmin = -9999, abline = c(0, 1), ...)

Value

0 in case of success

Note

It makes a plot betwee x and y and shows thair respective probibilty histograms. If y is missing, it is automatically calculated as one-dimensional Gaussianization of x through the function normalizeGaussian_severalstations.

See Also

plot.default,extractmonths, see normalizeGaussian_severalstations

Examples

```
## Not run:

library(lubridate)
data(trentino)
plot_sample(x=TEMPERATURE_MIN$T0090,sample="monthly",
 origin="1958-1-1",axes=FALSE,xlab="Tn [ degC]",
 ylab="x")

set.seed(123456)
z <- rexp(10000,rate=0.5)
x <- normalizeGaussian(x=z,data=z)
plot_sample(x=z,xlab="z",ylab="x")

## End(Not run)
```

PrecipitationEndDay *Gets the last day in a precipitation time series, expressed in decimal julian days since 1970-1-1 00:00 UTC*

Description

@author Emanuele Cordano, Emanuele Eccel

Usage

```
PrecipitationEndDay(name, station_names, end_day)
```

Arguments

name	charcacter ID of the station
station_names	vector containing the IDs (characters) of the considered meteorological stations. An example is STATION_NAMES defined in trentino.
end_day	vector containing the measurement end day. An example is TEMPERATURE_MEASUREMENT_END_DAY defined in trentino.

Value

the precipitation measurement end day given the vectors of station IDs and the precipitation measurement end days

Examples

```
data(trentino)
PrecipitationEndDay("T0099",station_names=STATION_NAMES,end_day=PRECIPITATION_MEASUREMENT_END_DAY)
```

PrecipitationStartDay *Gets the first day in a precipitation time series, expressed in decimal julian days since 1970-1-1 00:00 UTC*

Description

@author Emanuele Cordano

Usage

```
PrecipitationStartDay(name, station_names, start_day)
```

Arguments

name	character ID of the station
station_names	vector containing the IDs (characters) of the considered meteorological stations. An example is STATION_NAMES defined in the trentino dataset.
start_day	vector containing the precipitation measurement start day. An example is TEMPERATURE_MEASUREMENT_ST defined in the trentino dataset.

Value

the precipitation measurement start day given the vectors of station IDs and the respective precipitation measurement start days

Examples

```
data(trentino)
PrecipitationStartDay("T0099",
     station_names=STATION_NAMES,
     start_day=PRECIPITATION_MEASUREMENT_START_DAY)
```

`print.GPCA` `print` *S3 method for* `GPCA` *or* `GPCA_iteration` *object*

Description

`print` S3 method for `GPCA` or `GPCA_iteration` object

Usage

```
## S3 method for class 'GPCA'
print(x, rmin = 1, rmax = 4, cmin = rmin, cmax = rmax, ...)

## S3 method for class 'GPCAiteration'
print(x, rmin = 1, rmax = 4, cmin = rmin, cmax = rmax, ...)
```

Arguments

`x`	a `GPCA` or `GPCAiteration` object
`rmin`, `rmax`, `cmin`, `cmax`	maximum and minimum rows and columns to be printed
`...`	passed arguments

See Also

`GPCA`,`GPCA_iteration`

`GPCA_iteration`

`qqplot.lagged` *This function creates a Q-Q plot of the* `lag`*-lag moving cumulative addition of the values in the samples* `x,y,z`

Description

This function creates a Q-Q plot of the `lag`-lag moving cumulative addition of the values in the samples `x,y,z`

Usage

```
qqplot.lagged(
  x = rnorm(1000),
  y = rnorm(1000),
  z = NULL,
  when = 1:length(x),
  lag = 1,
  pch = 1,
  ...
)
```

Arguments

x, y	samples. If x is a data frame, y and z can be omitted.
z	further samples organized as a list
when	(integer) inidices of x and y on which the Q-Q plot is made.
lag	lag (current index included) on whose value the addition is made.
pch	a vector of plotting characters or symbols: see points
...	further arguments for qqplot

Value

the Q-Q plot

See Also

qqplot

---

qqplotprecWGEN *Makes a qqplot of measured and simulated data for several stations.*

Description

Makes a qqplot of measured and simulated data for several stations.

Usage

```
qqplotprecWGEN(
  measured,
  simulated,
  xlab = "simulated[mm]",
  ylab = "measured[mm]",
  title = "daily precipitation",
  station = NULL,
  diff = FALSE,
  quantile = 0
)
```

Arguments

measured	matrix containing measured data (each station corresponds to a column)
simulated	matrix containing respective generated data (each station corresponds to a column)
xlab, ylab	see plot.default,qqplotWGEN
title	title
station	character vector containing IDs of analyzed stations. If NULL (default) all stations (columns of simulated and measured) are considered
diff, quantile	see qqplotWGEN

Value

0 in case of success

Note

It uses qqplotWGEN and makes a figure for each pair of columns from measured and simulated. See the R code for further details.

Author(s)

Emanuele Cordano, Emanuele Eccel

---

qqplotprecWGEN_seasonal

Makes four seasonal qqplots (winter, spring, summer and autumn) of measured and simulated data for several stations.

Description

Makes four seasonal qqplots (winter, spring, summer and autumn) of measured and simulated data for several stations.

Usage

```
qqplotprecWGEN_seasonal(
  measured,
  simulated,
  origin = "1961-1-1",
  xlab = "simulated[mm]",
  ylab = "measured[mm]",
  title = "daily_precipitation",
  directorypdf,
  station = names(simulated)
)
```

Arguments

measured	matrix containing measured data (each station corresponds to a column)
simulated	matrix containing respective generated data (each station corresponds to a column)
origin	first day of data, see extractmonths for format and other information
xlab, ylab	see plot.default,qqplotWGEN
title	title
directorypdf	name of the directory (path included) where to seva the outputs
station	character vector containing IDs of analyzed stations. If NULL (default) all stations (columns of simulated and measured) are considered

Value

0 in case of success

Note

Uses qqplotprecWGEN for each season of collected data and saves the output on pdf files. See the R code for further details.

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

qqplotprecWGEN,extractmonths

---

qqplotTnTxWGEN *Makes a qqplot of measured and simulated data for several stations.*

Description

Makes a qqplot of measured and simulated data for several stations.

Usage

```
qqplotTnTxWGEN(
  measured,
  simulated,
  xlab = "simulated[degC]",
  ylab = "measured[degC]",
  titles = c("Q-Qplot_An._Tx", "Q-Qplot_An._Tn"),
  station = NULL,
  diff = FALSE,
  quantile = 0
)
```

Arguments

measured	matrix containing measured data (each station corresponds to a column)
simulated	matrix containing respective generated data (each station corresponds to a column)
xlab, ylab	see plot.default,qqplotWGEN
titles	titles that will be added to main argument of plot.default
station	character vector containing IDs of analyzed station. If NULL (default) all station (columns of simulated and measured) are considered
diff, quantile	see qqplotWGEN

Value

0 in case of success

Note

It uses qqplotWGEN and makes a figure for each pair of columns from measured and simulated. See the R code for further details.

Author(s)

Emanuele Cordano, Emanuele Eccel

---

qqplotTnTxWGEN_seasonal

Makes four seasonal qqplots (winter, spring, summer and autumn) of measured and simulated data for several stations.

Description

Makes four seasonal qqplots (winter, spring, summer and autumn) of measured and simulated data for several stations.

Usage

```
qqplotTnTxWGEN_seasonal(
  measured,
  simulated,
  origin = "1961-1-1",
  xlab = "simulated[degC]",
  ylab = "measured[degC]",
  titles = c("Q-Qplot_An._Tx", "Q-Qplot_An._Tn"),
  directorypdf,
  station = NULL
)
```

Arguments

measured	matrix containing measured data (each station corresponds to a column)
simulated	matrix containing respective generated data (each station corresponds to a column)
origin	first day of data, see extractmonths for format and other information
xlab, ylab	see plot.default,qqplotWGEN
titles	titles that will be added
directorypdf	name of the directory (path included) where to seva the outputs
station	character vector containing IDs of analyzed station. If NULL (default) all station (columns of simulated and measured) are considered

Value

0 in case of success

Note

Uses qqplotTnTxWGEN for each seasons of collected data and saves the output on pdf files. See the R code for further details.

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

qqplotTnTxWGEN,extractmonths

---

qqplotWGEN *Makes a qqplot and Wilcoxon test between the two columns of* val

---

Description

Makes a qqplot and Wilcoxon test between the two columns of val

Usage

```
qqplotWGEN(
  val,
  xlab = "simulated",
  ylab = "measured",
  main = "title",
  ylim = c(min(val), max(val)),
  xlim = c(min(val), max(val)),
  diff = FALSE,
  quantile = 0
)
```

Arguments

val	a matrix with two columns containing the two samples to be compared
xlab, ylab, main	see plot.default
xlim, ylim	see plot.default
diff	logical variable, if TRUE the function is applied to diff(val) instead of val. See diff
quantile	quantile value on which data samples in val are considered. Default is 0.

Value

Wilcoxon test between the two columns of 'val'

Author(s)

Emanuele Cordano, Emanuele Eccel

---

qqplot_RMAWGEN_Tx *It makes the Q-Q plots observed vs generated time series of daily maximum, minimum temperature and daily thermal range for a list of collected stochastic generations*

Description

It makes the Q-Q plots observed vs generated time series of daily maximum, minimum temperature and daily thermal range for a list of collected stochastic generations

Usage

```
qqplot_RMAWGEN_Tx(
  Tx_mes,
  Tx_gen,
  Tn_gen,
  Tn_mes,
  Tx_spline = NULL,
  Tn_spline = NULL,
  xlab = "observed",
  ylab = "simulated",
  when = 1:nrow(Tx_mes),
  main = names(Tx_gen),
  station,
  pdf = NULL,
  xlim = range(Tx_mes),
  ylim = xlim,
  cex = 0.4,
  cex.main = 1,
  cex.lab = 1,
```

```
  cex.axis = 1
)

qqplot_RMAWGEN_Tn(
  Tx_mes,
  Tx_gen,
  Tn_gen,
  Tn_mes,
  Tx_spline = NULL,
  Tn_spline = NULL,
  xlab = "observed",
  ylab = "simulated",
  when = 1:nrow(Tn_mes),
  main = names(Tn_gen),
  station,
  pdf = NULL,
  xlim = range(Tn_mes),
  ylim = xlim,
  cex = 0.4,
  cex.main = 1,
  cex.lab = 1,
  cex.axis = 1
)

qqplot_RMAWGEN_deltaT(
  Tx_mes,
  Tx_gen,
  Tn_gen,
  Tn_mes,
  xlab = "observed",
  ylab = "simulated",
  when = 1:nrow(Tx_mes),
  main = names(Tx_gen),
  station,
  pdf = NULL,
  xlim = range(Tx_mes - Tn_mes),
  ylim = xlim,
  cex = 0.4,
  cex.main = 1,
  cex.lab = 1,
  cex.axis = 1
)

qqplot_RMAWGEN_prec(
  prec_mes,
  prec_gen,
  xlab = "observed",
  ylab = "simulated",
```

```
  when = 1:nrow(prec_mes),
  main = names(prec_gen),
  station,
  pdf = NULL,
  xlim = range(prec_mes),
  ylim = xlim,
  cex = 0.4,
  cex.main = 1,
  cex.lab = 1,
  cex.axis = 1,
  lag = 1
)
```

Arguments

Tx_mes	data frame containing measured daily maximum temperature
Tx_gen	data frame containing generated daily maximum temperature
Tn_gen	data frame containing generated daily minimum temperature
Tn_mes	data frame containing measured daily minimum temperature
Tx_spline	data frame containing spline-interpolated daily maximum temperature. Default is NULL and not considered for Q-Q plot.
Tn_spline	data frame containing spline-interpolated daily minimum temperature Default is NULL and not considered for Q-Q plot.
xlab, ylab	lables of x and y axes. See qqplot.
when	day indices on which the data frame are extracted for Q-Q plot. Default is 1:nrow(Tn_mes) (in qqplot_RMAWGEN_Tn) or 1:nrow(Tx_mes) (otherwise)
main	main titles for each plot. Default is names(Tn_gen) (in qqplot_RMAWGEN_Tn) or names(Tx_gen) (otherwise)
station	identification name (ID) of the station used for the Q-Q plot
pdf	name of pdf file if output is written in a pdf file
xlim	see qqplot. Default is range(Tn_mes) (in qqplot_RMAWGEN_Tn) or range(Tx_mes) (in qqplot_RMAWGEN_Tx) .or range(Tx_mes-Tn_mes) (in qqplot_RMAWGEN_deltaT)
ylim, cex, cex.main, cex.lab, cex.axis	see qqplot and plot
prec_mes	data frame containing measured daily precipitation (in millimeters)
prec_gen	data frame containing generated daily precipitation (in millimeters)
lag	lag (current index included) on whose value the precipitation addition is made. See qqplot.lagged.

Note

Tx_gen,Tn_gen and main must have an even number of elements.

Author(s)

Emanuele Cordano

`removeNAs` *Replaces each entry of the rows containing NA values with NA*

Description

Replaces each entry of the rows containing NA values with NA

Usage

```
removeNAs(data)
```

Arguments

`data`	a matrix @author Emanuele Cordano, Emanuele Eccel

Value

the matrix `data` with the modified rows of NA values

Note

In `getVARmodel`, when using `VAR` or `VARselect`, all NAs will be removed

See Also

`getVARmodel`

`rescaling_monthly` *This function adjusts the monthly mean to a daily weather dataset (e. g. spline-interpolated temperature)*

Description

This function adjusts the monthly mean to a daily weather dataset (e. g. spline-interpolated temperature)

Usage

```
rescaling_monthly(data, val, origin = "1961-1-1")
```

Arguments

`data`	data frame of wheather variables)
`val`	monthly means returned by `getMonthlyMean`
`origin`	character string containing the gregorian date of the first day of `data`

Value

A data frame with data of `data` rescaled with `val` for each month

Note

It uses `months` and `julian`

Author(s)

Emanuele Cordano

@export

See Also

`extractdays`

`residuals.varest2` `residuals` *S3 method for* `varest2` *object*

Description

`residuals` S3 method for `varest2` object

Usage

```
## S3 method for class 'varest2'
residuals(object, squared = FALSE, ...)
```

Arguments

`object`	a `blockmatrix` object
`squared`	logical value. Default is `FALSE`. If `TRUE` the method returns the squared residuals.
`...`	passed arguments

Value

residuals of `object` as a data frame. In case `squared=TRUE` , the squared residauls are returned, otherwise simple residuals are returned. The squared residuals can be useful in case of ARCH analysis.

Author(s)

Emanuele Cordano

`serial_test` `serial.test` *function for* `varest2` *object*

Description

`serial.test` function for `varest2` object

Usage

```
serial_test(object, ...)
```

Arguments

`object`	a `varest2` object
`...`	passed arguments

See Also

`serial.test`

`setComprehensiveTemperatureGeneratorParameters`
Computes climatic and correlation information useful for creating an auto-regeressive random generation of maximum and minimun daily temparature. This function is called by `ComprehensiveTemperatureGenerator`.

Description

Computes climatic and correlation information useful for creating an auto-regeressive random generation of maximum and minimun daily temparature. This function is called by `ComprehensiveTemperatureGenerator`.

Usage

```
setComprehensiveTemperatureGeneratorParameters(
  station,
  Tx_all,
  Tn_all,
  mean_climate_Tn = NULL,
  mean_climate_Tx = NULL,
  Tx_spline = NULL,
  Tn_spline = NULL,
  year_max = 1990,
  year_min = 1961,
  leap = TRUE,
```

```
  nmonth = 12,
  verbose = FALSE,
  cpf = NULL,
  normalize = TRUE,
  sample = NULL,
  option = 2,
  yearly = FALSE
)
```

Arguments

station	character vector of the IDs of the considered meteorological stations
Tx_all	data frame containing daily maximum temperature of all meteorological station. See TEMPERATURE_MAX for formatting.
Tn_all	data frame containing daily minimum temperature of all meteorological station. See TEMPERATURE_MIN for formatting.
mean_climate_Tn	a matrix containing monthly mean minimum daily temperature for the considered station or an object as returned by getMonthlyMean. If NULL, it is calculated. See input of is.monthly.climate
mean_climate_Tx	a matrix containing monthly mean maximum daily temperature for the considered station or an object as returned by getMonthlyMean. If NULL, it is calculated. See input of is.monthly.climate
Tx_spline	daily timeseries (from the first day of year_min to the last day of year_max) of averaged maximum temperature which can be obtained by a spline interpolation of monthly mean values. Default is NULL and returned as output. See for spline interpolation utilized: splineInterpolateMonthlytoDailyforSeveralYears.
Tn_spline	daily timeseries (from the first day of year_min to the last day of year_max) of averaged minimum temperature which can be obtained by a spline interpolation of monthly mean values. Default is NULL and returned as output. See for spline interpolation utilized: splineInterpolateMonthlytoDailyforSeveralYears.
year_max	start year of the recorded (calibration) period
year_min	end year of the recorded (calibration) period
leap	logical variables. It is TRUE (Default) if leap years are considered
nmonth	number of months in one year. Default is 12.
verbose	logical variable
cpf	see normalizeGaussian_severalstations
normalize	logical variable If TRUE normalizeGaussian_severalstations is used, otherwise it is not. If option is 2, it is always TRUE.
sample	see normalizeGaussian_severalstations
option	integer value. If 1, the generator works with minimum and maximum temperature, if 2 (default) it works with the average value between maximum and minimum temperature and the respective daily thermal range.
yearly	logical value. If TRUE the monthly mean values are calculated for each year from year_min to year_max separately. Default is FALSE.

Value

This function creates and returns the following gloabal variables:

`data_original` matrix containing normalized and standardized data (i.e. `data_original`)

`data_for_var` matrix returned from `normalizeGaussian_severalstations` by processing `data_original` if `normalize` is `TRUE`), otherwise it is equal to `data_original`.

`Tn_mes` matrix containing measured minimum daily temperature in the analyzed time period (Tn_{mes})

`Tx_mes` matrix containing measured maximum daily temperature in the analyzed time period (Tx_{mes})

`Tm_mes` matrix calculated as to

$$\frac{Tx_{mes} + Tn_{mes}}{2}$$

`DeltaT_mes` matrix corresponding to $Tx_{mes} - Tn_{mes}$

`monthly_mean_Tn` matrix containing monthly means of minimum daily temperature for the considered station. It is calculated according to the input format `is.monthly.climate` if `saveMonthlyClimate` is `TRUE`.

`monthly_mean_Tx` matrix containing monthly means of maximum daily temperature for the considered station. It is calculated according to the input format `is.monthly.climate` if `saveMonthlyClimate` is `TRUE`.

`Tx_spline` matrix containing the averaged daily values of maximimum temperature obtained by a spline interpolation of the monthly climate `monthly_mean_Tx` or `mean_climate_Tx` using `splineInterpolateMonthlytoDa` (Tx_s)

`Tn_spline` matrix containing the averaged daily values of minimun temperature obtained by a spline interpolation of the monthly climate `monthly_mean_Tn` or `mean_climate_Tn` using `splineInterpolateMonthlytoDa` (Tn_s)

`SplineAdvTm` matrix calculated as $\frac{Tx_s+Tn_s}{2}$

`SplineAdvDeltaT`, matrix corresponding to $Tx_s - Tn_s$

`stdTn` vector containing the standard deviation of minimum temperature anomalies $Tn_{mes} - Tn_s$ (σ_{Tn})

`stdTx` vector containing the standard deviation of maximum temperature anomalies $Tx_{mes} - Tx_s$ (σ_{Tx})

`stdTm` vector containing the standard deviation of "mean" temperature anomalies $Tm_{mes} - Tm_s$ (σ_{Tm})

`Tn_mes_res` standard core (standardization) of Tn_mes obtained by solving column by column the expression

$$\frac{Tn_{mes} - Tn_s}{\sigma_{Tn}}$$

`Tx_mes_res` standard core (standardization) of Tx_mes obtained by solving column-by-column the expression

$$\frac{Tx_{mes} - Tn_s}{sd_{Tm}}$$

`Tm_mes_res` standard core (standardization) of Tm_mes obtained by solving column-by-column the expression

$$\frac{Tm_{mes} - Tn_s}{sd_{Tm}}$$

`DeltaT_mes_res` equal to `DeltaT_mes`

`data_original` matrix obtained as `cbind(Tx_mes_res,Tn_mes_res)` if `option==1`, or `cbind(Tm_mes_res,DeltaT_mes_r` if `option==2`

See the R code for further details.

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

`splineInterpolateMonthlytoDailyforSeveralYears`,`ComprehensiveTemperatureGenerator`

`splineInterpolateMonthlytoDaily` *Interpolates monthly data to daily data using* `spline` *and preserving monthly mean values*

Description

Interpolates monthly data to daily data using `spline` and preserving monthly mean values

Usage

```
splineInterpolateMonthlytoDaily(
  nday = 365,
  val = as.matrix(cbind(1 * (0.5:11.5) * nday/12, 2 * (0.5:11.5) * nday/12)),
  origin = "1961-1-1",
  first_row = 1,
  last_row = nday,
  no_spline = FALSE,
  no_mean = FALSE
)
```

Arguments

`nday`	number of days on which the daily data is requested, e.g. number of days in one year
`val`	matrix containing monthly mean data
`origin`	date corresponding to the first row of the returned matrix
`first_row`	row corresponding the first day of time interval where montlhy mean conservation is applied

last_row	corresponding the last day of time interval where montlhy mean conservation is applied
no_spline	logical value. If TRUE no spline interpolation is calculated and the daily value corresponds to the monthly average value. Default is FALSE.
no_mean	logical value. Default is FALSE. If TRUE the function output is not rescaled in order to maintain observed mean monthly values.

Value

a matrix or data frame with interpolated daily data

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

spline,splineInterpolateMonthlytoDailyforSeveralYears

---

splineInterpolateMonthlytoDailyforSeveralYears *Interpolates monthly data to daily data using* splineInterpolateMonthlytoDaily *for several years*

Description

Interpolates monthly data to daily data using splineInterpolateMonthlytoDaily for several years

Usage

```
splineInterpolateMonthlytoDailyforSeveralYears(
  val,
  start_year = 2010,
  nyear = 1,
  leap = TRUE,
  offset = 2,
  no_spline = FALSE,
  yearly = FALSE
)
```

Arguments

val	matrix containing monthly mean data for one year
start_year	first year
nyear	number of years since start_year

leap	logical variable If TRUE (default) leap years are considered, otherwise they are not
offset	integer values. Default is 2. Number of years considered beyond the extremes in order to avoid edge errors
no_spline	logical value. If TRUE no spline interpolation is calculated and the daily value corresponds to the monthly average value. Default is FALSE.
yearly	logical value. If TRUE the result with men value per each month per each year. Default is FALSE.
	@return a matrix or data frame with interpolated daily data

Author(s)

Emanuele Cordano, Emanuele Eccel

See Also

spline,splineInterpolateMonthlytoDaily

TemperatureEndDay *Gets the last day in a temperature time series, expressed as decimal julian days since 1970-1-1 00:00 UTC*

Description

Gets the last day in a temperature time series, expressed as decimal julian days since 1970-1-1 00:00 UTC

Usage

```
TemperatureEndDay(name, station_names, end_day)
```

Arguments

name	character ID of the station
station_names	vector containing the IDs (characters) of the considered meteorological stations. An example is STATION_NAMES defined in the trentino dataset.
end_day	vector containing the measurement end day. An example is TEMPERATURE_MEASUREMENT_END_DAY defined in the trentino dataset.

Value

the temperature measurement end day given the vectors of station IDs and the temperature measurement end days

Author(s)

Emanuele Cordano, Emanuele Eccel

Examples

```
data(trentino)
TemperatureEndDay("T0099",station_names=STATION_NAMES,end_day=TEMPERATURE_MEASUREMENT_END_DAY)
```

`TemperatureStartDay` *Gets the first day in a temperature time series, expressed as decimal julian days since 1970-1-1 00:00 UTC*

Description

@author Emanuele Cordano, Emanuele Eccel

Usage

```
TemperatureStartDay(name, station_names, start_day)
```

Arguments

`name`	character ID of the station
`station_names`	vector containing the IDs (characters) of the considered meteorological stations. An example is `STATION_NAMES` defined in the `trentino` dataset.
`start_day`	vector containing the temperature measurement start day. Default is `TEMPERATURE_MEASUREMENT_START_` defined in the `trentino` dataset.
	@export

Value

the temperature measurement start day given the vectors of station IDs and the respective temperature measurement start days

@examples data(trentino) TemperatureStartDay("T0099",station_names=STATION_NAMES,start_day=TEMPERATURE_

`trentino` *Trentino Dataset*

Description

It contains the following variables:

`TEMPERATURE_MIN` Data frame containing `year`,`month` , `day` and daily minimum temperature in 59 stations in Trentino region

`TEMPERATURE_MAX` Data frame containing `year`,`month` , `day` and daily maximum temperature in 59 stations in Trentino region

PRECIPITATION Data frame containing year,month , day and daily precipitation in 59 stations in Trentino region

STATION_NAMES Vector containing the names of the meteorological stations

ELEVATION Vector containing the elevations of the meteorological stations respectively

STATION_LATLON Matrix containing the latitude and longitude coordinates, respectively, of the meteorological stations

LOCATION Vector containing the names of the location of each meteorological station

TEMPERATURE_MEASUREMENT_START_DAY Vector containing the first days referred to midday (expressed as decimal julian day since 1970-1-1 00:00 UTC) of temperature measurement of each meteorological station

TEMPERATURE_MEASUREMENT_END_DAY Vector containing the last days referred to midday (expressed as decimal julian day since 1-1-1970 00:00 UTC) of temperature measurement of each meteorological station

PRECIPITATION_MEASUREMENT_START_DAY Vector containing the first days referred to midday (expressed as decimal julian day since 1-1-1970 00:00 UTC) of precipitation measurement of each meteorological station

PRECIPITATION_MEASUREMENT_END_DAY Vector containing the last days referred to midday (expressed as decimal julian day since 1-1-1970) of precipitation measurement of each meteorological station

Usage

```
data(trentino)
```

Format

Data frames and vectors

Details

This dataset stores all information about meteorological stations and instrumental timeseries. The user can easily use the package with his/her own data after replacing the values of such variables.

Source

Original data are provided by Provincia Autonoma di Trento (https://www.meteotrentino.it/), Fondazione Edmund Mach (https://www.fmach.it), Provincia Autonama di Bolzano/Autome Provinz Bozen, ARPA Lombardia, ARPA Veneto (Italy).

This dataset is intended for research purposes only, being distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY.

varest-class *varest-class*

Description

`varest` S3 class (formal definition) see `VAR`

Details

The details of the class are reported on `VAR` documentation in "vars" package

Note

Formal definition with `setOldClass` for the S3 class `varest`

Author(s)

Bernhard Pfaff

Examples

```
showClass("varest")
```

varest2-class *varest2-class*

Description

This class derives from a `varest` S3 class which is a list of objects describing a Vectorial AutoRegressive Model (see `VAR`)

Details

`VAR`: a `varest` S3 object created by `VAR`

Note

A `varest2` object can be created by `new("varest2", ...)` or returned by the function `getVARmodel`

Author(s)

Emanuele Cordano

Examples

```
showClass("varest2")
```

`VAR_mod` *Modified version of* `VAR` *function allowing to describe white-noise as VAR-(0) model (i. e.* `varest` *objects)*

Description

Modified version of `VAR` function allowing to describe white-noise as VAR-(0) model (i. e. `varest` objects)

Usage

```
VAR_mod(
  y,
  p = 1,
  type = c("const", "trend", "both", "none"),
  season = NULL,
  exogen = NULL,
  lag.max = NULL,
  ic = c("AIC", "HQ", "SC", "FPE")
)
```

Arguments

`y`, `p`, `type`, `season`, `exogen`, `lag.max`, `ic`
see `VAR` function

Value

a Vector Auto-Regeressive model (VAR) as `varest` object

`WhereIs` *Gets the toponym where a meteorological station is located*

Description

Gets the toponym where a meteorological station is located

Usage

```
WhereIs(name, station_names, location)
```

Arguments

name	character ID of the station
station_names	vector containing the IDs (characters) of the considered meteorological stations. An example is STATION_NAMES defined in the trentino dataset.
location	vector containing the toponyms. An example is LOCATION defined in the trentino dataset.

Value

the location toponym given the vectors of station IDs and the respective location toponyms

Author(s)

Emanuele Cordano, Emanuele Eccel

Examples

```
data(trentino)
WhereIs("T0099",station_names=STATION_NAMES,location=LOCATION)
```

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