## Package ‘hydroTSM’

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**Type** Package

**Title** Time series management, analysis and interpolation for hydrological modelling

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**Maintainer** Mauricio Zambrano-Bigiarini <mzb.devel@gmail.com>

**Description**
S3 functions for management, analysis, interpolation and plotting of time series used in hydrology and related environmental sciences. In particular, this package is highly oriented to hydrological modelling tasks. The focus of this package has been put in providing a collection of tools useful for the daily work of hydrologists (although an effort was made to optimise each function as much as possible, functionality has had priority over speed). Bugs / comments / questions / collaboration of any kind are very welcomed, and in particular, datasets that can be included in this package for academic purposes.

**License** GPL (>= 2)

**Depends** R (>= 2.10.0), zoo (>= 1.7-2), xts (>= 0.8-2)

**Imports** e1071, gstat, automap, sp

**Suggests** rgdal, maptools, lattice

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**MailingList** [https://stat.ethz.ch/mailman/listinfo/r-sig-ecology](https://stat.ethz.ch/mailman/listinfo/r-sig-ecology)

**BugReports** [https://www.rforge.net/bugzilla/describecomponents.cgi?product=hydroTSM](https://www.rforge.net/bugzilla/describecomponents.cgi?product=hydroTSM)

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hydroTSM-package

Management, analysis, interpolation and plot of hydrological time series, with focus on hydrological modelling

Description

S3 functions for management, analysis, interpolation and plotting of time series used in hydrology and related environmental sciences. In particular, this package is highly oriented to hydrological modelling tasks. The focus of this package has been put in providing a collection of tools useful for the daily work of hydrologists (although an effort was made to optimise each function as much as possible, functionality has had priority over speed). Bugs / comments / questions / collaboration of any kind are very welcomed, and in particular, datasets that can be included in this package for academic purposes.

Details

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Author(s)

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Maintainer: Mauricio Zambrano-Bigiarini <mzb.devel@gmail>

See Also

http://www.rforge.net/hydroGOF/
http://www.rforge.net/hydroPSO/

Examples

## Loading the monthly time series (10 years) of precipitation for the Ebro River basin.
data(EbroPPtsMonthly)

####

## Ex1) Graphical correlation among the ts of monthly precipitation of the first
## 3 stations in 'EbroPPTSMonthly' (its first column stores the dates).
hydropairs(EbroPPTSMonthly[,2:4])

```
## Ex2) Annual values of precipitation at the station "P9001"
sname2ts(EbroPPTSMonthly, sname="P9001", dates=1, var.type="Precipitation",
tstep.out="annual")
```

```
## Ex3) Monthly and annual plots
sname2plot(EbroPPTSMonthly, sname="P9001", var.type="Precipitation", dates=1, pfreq="ma")
```

```
## Ex4) IDW interpolation and plot
## Loading the spatial data corresponding to 'EbroPPTSMonthly'
data(EbroPPGis)

## Loading the shapefile (polygon) with the subcatchments
data(EbroCatchmentsCHE)

## Selecting the first day of 'EbroPPTSMonthly' for all the stations
x.ts <- as.numeric(EbroPPTSMonthly[,2:ncol(EbroPPTSMonthly)])

## Setting the name of the gauging stations
names(x.ts) <- colnames(EbroPPTSMonthly[,2:ncol(EbroPPTSMonthly)])

# Computing the interpolated values and plotting them
# Probably you will need to resize your window
# Not run:
x.idw <- hydrokrige(x.ts= x.ts, x.gis=EbroPPGis,
                   X="EAST_ED50", Y="NORTH_ED50", sname="ID",
                   bname= "CHE_BASIN_NAME", elevation="ELEVATION",
                   type= "both",
                   subcatchments= EbroCatchmentsCHE,
                   cell.size= 1000)

## Ex5) Mean monthly values of streamflows
## Loading daily streamflows (3 years) at the station
## Oca en Ona (Ebro River basin, Spain)
data(OcaEnOnaQts)
monthlyFunction(OcaEnOnaQts, FUN=mean, na.rm=TRUE)
Description

Generic function for transforming a (sub)DAILY/MONTHLY (weekly and quarterly) regular time series into an ANNUAL one.

Usage

daily2annual(x, ...)  
subdaily2annual(x, ...)  
monthly2annual(x, ...)

## Default S3 method:
daily2annual(x, FUN, na.rm = TRUE, out.fmt = "%Y", ...)

## S3 method for class 'zoo'
daily2annual(x, FUN, na.rm = TRUE, out.fmt = "%Y-%m-%d", ...)

## S3 method for class 'data.frame'
daily2annual(x, FUN, na.rm = TRUE, out.fmt = "%Y", dates=1,  
        date.fmt = "%Y-%m-%d", out.type = "data.frame", verbose = TRUE, ...)

## S3 method for class 'matrix'
daily2annual(x, FUN, na.rm = TRUE, out.fmt = "%Y", dates=1,  
        date.fmt = "%Y-%m-%d", out.type = "data.frame", verbose = TRUE, ...)

Arguments

x zoo, xts, data.frame or matrix object, with (sub)daily/monthly time series. Measurements at several gauging stations can be stored in a data.frame or matrix object, and in that case, each column of x represent the time series measured in each gauging station, and the column names of x have to correspond to the ID of each station (starting by a letter).

FUN Function that have to be applied for aggregating from (sub)daily/monthly into annual time step (e.g., for precipitation FUN=sum and for temperature and stream-flows ts, FUN=mean).

na.rm Logical. Should missing values be removed?
  -> TRUE : the monthly and annual values are computed considering only those values different from NA
  -> FALSE: if there is AT LEAST one NA within a year, the corresponding annual value is NA.

out.fmt Character indicating the date format for the output time series. See format in as.Date. Possible values are:
  -> %Y : only the year will be used for the time. Default option. (e.g., "1961" "1962"...)
  -> %Y-%m-%d: a complete date format will be used for the time. (e.g., "1961-01-01" "1962-01-01"...)

dates numeric, factor or Date object indicating how to obtain the dates for corresponding to each gauging station
If dates is a number (default), it indicates the index of the column in x that stores the dates.

If dates is a factor, it is converted into Date class, using the date format specified by date.fmt.

If dates is already of Date class, the code verifies that the number of days on it be equal to the number of element in x.

- date.fmt: character indicating the format in which the dates are stored in dates, e.g. "%Y-%m-%d.
- See format in as.Date.

- out.type: Character that defines the desired type of output. Valid values are:
  - data.frame: a data.frame, with as many columns as stations are included in x, and row names indicating the Year.
  - db: a data.frame, with 3 columns will be produced. The first column (StationID) will store the ID of the station. The second column (Year) will store the year, The third column (Value) will contain the annual value corresponding to the two previous columns.

- verbose: logical; if TRUE, progress messages are printed.

... further arguments passed to or from other methods.

Value

a zoo object with annual frequency

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

See Also

daily2monthly, monthly2annual, hydroplot, annualfunction, vector2zoo, as.Date

Examples

# Ex1: Loading the DAILY precipitation data at SanMartino
data(SanMartinoPPts)
x <- SanMartinoPPts

# Daily to Annual
daily2annual(x, FUN=sum, na.rm=TRUE)

# Ex2: Monthly to Annual (same result as )
m <- daily2monthly(x, FUN=sum, na.rm=TRUE)
monthly2annual(m, FUN=sum, na.rm=TRUE)
## (sub)daily2monthly

### Description

Generic function for transforming a DAILY (sub-daily or weekly) regular time series into a MONTHLY one.

### Usage

```r
daily2monthly(x, ...)  
subdaily2monthly(x,  
## Default S3 method:  
daily2monthly(x, FUN, na.rm = TRUE,  
## S3 method for class 'zoo'  
daily2monthly(x, FUN, na.rm = TRUE,  
## S3 method for class 'data.frame'  
daily2monthly(x, FUN, na.rm = TRUE, dates=1, date.fmt = "%Y-%m-%d",  
## S3 method for class 'matrix'  
daily2monthly(x, FUN, na.rm = TRUE, dates=1, date.fmt = "%Y-%m-%d",  
```

### Arguments

- `x` zoo, xts, data.frame or matrix object, with daily/monthly time series. Measurements at several gauging stations can be stored in a data.frame or matrix.
object, and in that case, each column of x represent the time series measured in each gauging station, and the column names of x have to correspond to the ID of each station (starting by a letter).

**FUN**

Function that have to be applied for transforming from daily to annual time step. (e.g., for precipitation FUN=sum and for temperature and streamflow ts, FUN=mean).

**na.rm**

Logical. Should missing values be removed?

- TRUE: the monthly and annual values are computed considering only those values different from NA
- FALSE: if there is AT LEAST one NA within a year, the monthly values are NA

**dates**

numeric, factor or Date object indicating how to obtain the dates for each gauging station

If dates is a number (default), it indicates the index of the column in x that stores the dates

If dates is a factor, it is converted into Date class, using the date format specified by date.fmt

If dates is already of Date class, the code verifies that the number of days on it be equal to the number of elements in x

**date.fmt**

character indicating the format in which the dates are stored in dates, e.g. %Y-%m-%d. See format in as.Date.

ONLY required when class(dates)=="factor" or class(dates)=="numeric".

**out.type**

Character that defines the desired type of output. Valid values are:

- data.frame: a data.frame, with as many columns as stations are included in x, and row names indicating the month and year for each value.
- db: a data.frame, with 4 columns will be produced.
  The first column (StationID) stores the ID of the station,
  The second column (Year) stores the year
  The third column (Month) stores the Month
  The fourth column (Value) stores the numerical values corresponding to the values specified in the three previous columns.

OPTIONAL. Only used when x is a matrix or data.frame object /cr character, for selecting if the result will be a matrix/data.frame or a zoo object. Valid values are: numeric, zoo.

**verbose**

logical; if TRUE, progress messages are printed

... further arguments passed to or from other methods.

**Author(s)**

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

**See Also**

daily2annual, subdaily2daily, monthlyfunction, hydroplot, vector2zoo, izoo2rzoo, as.Date
Examples

### Ex1: Loading the Daily precipitation data at SanMartino
```r
data(SanMartinoPPts)
x <- SanMartinoPPts

## Daily to monthly
m <- daily2monthly(x, FUN=sum, na.rm=TRUE)
```

### Ex2: Loading the time series of Hourly streamflows for the station Karamea at Gorge
```r
data(KarameaAtGorgeQts)
x <- KarameaAtGorgeQts

## Sub-daily to monthly ts
subdaily2monthly(x, FUN=mean, na.rm=TRUE)
```

---

### annualfunction

#### Annual Function

**Description**

Generic function for obtaining a SINGLE annual value of a zoo object, by applying any R function to ALL the values in `x` belonging to the same year, and then applying the same function to ALL the previously computed annual values (e.g., for computing the average annual precipitation or the mean annual streamflow of a long-term time series).

**Usage**

```r
annualfunction(x, FUN, na.rm = TRUE, ...)
```

## Default S3 method:
```r
annualfunction(x, FUN, na.rm = TRUE, ...)
```

## S3 method for class 'zoo'
```r
annualfunction(x, FUN, na.rm = TRUE, ...)
```

## S3 method for class 'data.frame'
```r
annualfunction(x, FUN, na.rm = TRUE, dates=1, date.fmt = "%Y-%m-%d", verbose = TRUE, ...)
```

## S3 method for class 'matrix'
```r
annualfunction(x, FUN, na.rm = TRUE, dates=1, date.fmt = "%Y-%m-%d", verbose = TRUE, ...)
```
annualfunction

Arguments

x  zoo, xts, data.frame or matrix object, with daily/monthly/annual time series. Measurements at several gauging stations can be stored in a data.frame of matrix object, and in that case, each column of x represent the time series measured in each gauging station, and the column names of x have to correspond to the ID of each station (starting by a letter).

FUN  Function that will be used to compute the final annual value (e.g., FUN may be some of mean, sum, max, min, sd).

na.rm  Logical. Should missing values be removed?

- TRUE: the annual values are computed considering only those values different from NA
- FALSE: if there is AT LEAST one NA within a year, the resulting annual value will be NA

dates  numeric, factor or Date object indicating how to obtain the dates corresponding to each gauging station.

If dates is a number (default), it indicates the index of the column in x that stores the dates
If dates is a factor, it have to be converted into Date class, using the date format specified by date.fmt
If dates is already of Date class, the code verifies that the number of days in dates be equal to the number of elements in x

date.fmt  character indicating the format in which the dates are stored in dates, e.g. %Y-%m-%d.

See format in as.Date.

ONLY required when class(dates)="factor" or class(dates)="numeric".

verbose  Logical; if TRUE, progress messages are printed.

...  further arguments passed to or from other methods.

Value

When x is a time series, a single annual value is returned.
For a data frame, a named vector with the appropriate method being applied column by column.

Note

FUN is first applied to all the values of x belonging to the same year and then it is applied to all the previously computed annual values to get the final result. Its result will depend on the sampling frequency of x and the type of function provided by FUN (special attention have to be put when FUN=sum)

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

See Also

monthlyfunction, daily2annual, monthly2annual, yip
Examples

```r
## Loading the SanMartino daily precipitation data (1921-1990)
data(SanMartinoPPpts)
x <- SanMartinoPPpts

# Amount of years in 'x' (needed for computing the average)
nyears <- length(seq(from=time(x[1]), to=time(x[length(x)]), by="years"))

## Average annual precipitation for the 70 years period.
# It is necessary to divide by the amount of years to obtain the average annual value,
# otherwise it will give the total precipitation for all the 70 years.
annualfunction(x, FUN=sum, na.rm=TRUE) / nyears

## verification

## Daily to annual
a <- daily2annual(x, FUN=sum, na.rm=TRUE)

## Mean annual value
mean(a)

## Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPPptsMonthly)
x <- EbroPPptsMonthly

## Dates of 'x'
dates <- as.Date(x[,1])

## Computation of the average annual precipitation
## Not run:

## Transforming 'x' into a zoo object
z <- zoo(x[, 2:ncol(x)], dates)

# Amount of years in 'x' (needed for computing the average)
nyears <- yip(from=start(z), to=end(z), out.type="nmb"r")

## Average annual precipitation, for the first 5 stations in 'x'
annualfunction(z[,1:5], FUN=sum)/nyears

## End(Not run)
```
Description

Given any starting and ending dates, it generates:
1) a vector of class Date with all the days between from and to (both of them included), OR
2) the amount of days between the two dates

Usage

dip(from, to, date.fmt = "%Y-%m-%d", out.type = "seq")

Arguments

from Character indicating the starting date for creating the sequence. It has to be in the format indicated by date.fmt.
to Character indicating the ending date for creating the sequence. It has to be in the format indicated by date.fmt.
date.fmt character indicating the format in which the dates are stored in from and to. e.g. %Y-%m-%d. See format in as.Date.
out.type Character indicating the type of result that is given by this function. Valid values are:
1) seq: a vector of class Date with all the days between the two dates, OR
2) nmbr: a single numeric value with the amount of days between the two dates.

Value

Depending on the value of out.type, it returns:
1) a vector of class Date with all the days between from and to (both of them included), OR
2) the amount of days between the two dates

Author(s)

Mauricio Zambrano-Bигiarini, <mzb.devel@gmail>

See Also

mip, yip, hip, diy

Examples

## Sequence of daily dates between "1961-01-01" and "1961-12-31" ##
dip("1961-01-01", "1961-12-31")

## Number of days between "1961-01-01" and "1965-06-30", ##
## but using "%d-%m-%Y" as date format.##
dip("01-01-1961", "30-06-1965", date.fmt= "%d-%m-%Y", out.type = "nmbr")
diy

---

**Description**

Given a single numeric value representing a year, it generates:
1) a vector of dates with all the days within the year, OR
2) the amount of days in the specified year

**Usage**

```r
diy(year, out.type = "seq")
```

**Arguments**

- `year`: numeric, the year for which the sequence of days will be generated
- `out.type`: Character indicating the type of result that is given by this function. Valid values are:
  - `seq`: a vectorial sequence with all the days within the given year
  - `nmbr`: the number of days in the vectorial sequence with all the days within the given year

**Author(s)**

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

**See Also**

`hip`, `dip`, `mip`, `yip`

**Examples**

```r
## Sequence of daily dates for the year 1961
diy(1961)

## Computing the number of days between in 1961
diy(1961, out.type = "nmbr")
```
Description

Generic function for computing a seasonal value for every year of a sub-daily/daily/weekly/monthly time series

Usage

```r
# Default S3 method:
dm2seasonal(x, season, FUN, na.rm = TRUE, out.fmt="%Y", ...)

# S3 method for class 'zoo'
dm2seasonal(x, season, FUN, na.rm = TRUE, out.fmt="%Y", ...)

# S3 method for class 'data.frame'
dm2seasonal(x, season, FUN, na.rm = TRUE, dates=1, date.fmt = "%Y-%m-%d",
            out.type = "data.frame", out.fmt="%Y", ...)

# S3 method for class 'matrix'
dm2seasonal(x, season, FUN, na.rm = TRUE, dates=1, date.fmt = "%Y-%m-%d",
            out.type = "data.frame", out.fmt="%Y", ...)
```

Arguments

- `x`: zoo, xts, data.frame or matrix object, with sub-daily, daily, weekly or monthly time series. Measurements at several gauging stations can be stored in a data.frame of matrix object, and in that case, each column of `x` represent the time series measured in each gauging station, and the column names of `x` have to correspond to the ID of each station (starting by a letter).
- `season`: character, indicating the weather season to be used for selecting the data. Valid values are:
  - DJF: December, January, February
  - MAM: March, April, May
  - JJA: June, July, August
  - SON: September, October, November
  - DJFM: December, January, February, March
  - AM: April, May
  - JIAS: June, July, August, September
  - ON: October, November
Function that will be applied to all the values of `x` belonging to the given weather season (e.g., `FUN` can be some of `mean`, `max`, `min`, `sd`).

The **FUN value for the winter season (DJF or DJFM)** is computed considering the consecutive months of December, January and February/March. See 'Note' section.

**na.rm**
Logical. Should missing values be removed?
- `TRUE` : the seasonal values are computed considering only those values different from NA (very important when `FUN=sum`)
- `FALSE` : if there is AT LEAST one NA within a weather season, the corresponding seasonal values are NA

**out.fmt**
Character indicating the date format for the output time series. See `format` in `as.Date`. Possible values are:
- `%Y` : only the year will be used for the time. Default option. (e.g., "1961" "1962"...)
- `%Y-%m-%d` : a complete date format will be used for the time. (e.g., "1961-01-01" "1962-01-01"...)

**dates**
numeric, factor or Date object indicating how to obtain the dates.
If `dates` is a number (default), it indicates the index of the column in `x` that stores the dates
If `dates` is a factor, it is converted into Date class, by using the date format specified by `date.fmt`
If `dates` is already of Date class, the code verifies that the number of days on it be equal to the number of elements in `x`

**date.fmt**
Character indicating the format in which the dates are stored in `dates`, e.g. `%Y-%m-%d`. See `format` in `as.Date`.
ONLY required when `class(dates)="factor"` or `class(dates)="numeric"`.

**out.type**
Character that defines the desired type of output. Valid values are:
- `data.frame` : a `data.frame`, with as many columns as stations are included in `x`, the year corresponding to each seasonal value are used as row names.
- `db` : a `data.frame`, with 4 columns will be produced.
The first column (StationID) stores the ID of the station The second column (Year) stores the year, The third column (Season) stores the season, The fourth column (Value) contains the seasonal value corresponding to the values specified in the previous three columns

... further arguments passed to or from other methods.

**Value**
A numeric vector with the seasonal values for all the years in which `x` is defined.

**Warning**
For any year, the `FUN` value for the winter season (DJF), is computed considering only January and February, and the value of December is used for computing the winter value of the next year.
Note

Note is applied to all the values of \( x \) belonging to the selected season, so the results of this function depend on the frequency sampling of \( x \) and the type of function given by \( \text{FUN} \).

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>.

See Also

\texttt{hydroplot, seasonalfunction, time2season, extract, daily2monthly, daily2annual, monthly2annual}

Examples

```
#####
## Loading the DAILY precipitation data at SanMartino
data(SanMartinoPpts)
x <- SanMartinoPpts

## Winter (DJF) values of precipitation for each year of 'x'
dm2seasonal(x, \text{FUN}=\text{sum}, \text{season}="DJF")

#####
## Loading the HOURLY discharge data for the Karamea at Gorge streamgauge station
data(KarameaAtGorgeQts)
x <- KarameaAtGorgeQts

## Mean winter (DJF) values of streamflow for each year of 'x'
dm2seasonal(x, \text{FUN}=\text{mean}, \text{season}="DJF")
subdaily2seasonal(x, \text{FUN}=\text{mean}, \text{season}="DJF") \# same as above
```

---

drawTimeAxis \hspace{1cm} \textit{Customized Time Axis}

Description

For a nice time series plot, this function draws a customized time axis, with annual, monthly, daily and sub-daily time marks and labels.

Usage

```
drawTimeAxis(x, \text{tick.tstep} = \text{"auto"}, \text{lab.tstep} = \text{"auto"},
\text{lab.fmt} = \text{NULL}, \text{cex.axis} = 1, \ldots)
```
**drawTimeAxis**

**Arguments**

- **x**: time series that will be plotted using the X axis that will be draw class(x) must be ts or zoo.
- **tick.tstep**: Character indicating the time step that have to be used for putting the ticks on the time axis. Valid values are: auto, years, quarters, months, weeks, days, hours, minutes, seconds.
- **lab.tstep**: Character indicating the time step that have to be used for putting the labels on the time axis. Valid values are: auto, years, quarters, months, weeks, days, hours, minutes, seconds.
- **lab.fmt**: Character indicating the format to be used for the label of the axis. See format in `as.Date`. If not specified (lab.fmt=NULL), it will try to use:
  - `"%Y-%m-%d"` when `lab.tstep="days```
  - `"%b-%Y"` when `lab.tstep="year"` or `lab.tstep="month"`.
- **cex.axis**: magnification of axis annotation relative to cex (See `par`).
- **...**: further arguments passed to the axis function or from other methods.

**Note**

From version 0.3-0 it changed its name from `drawxaxis` to `drawTimeAxis`, in order to have a more intuitive name. The old `drawxaxis` function is deprecated, but still be kept for compatibility reasons.

**Author(s)**

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

**Examples**

```r
## Loading the SanMartino precipitation data
data(SanMartinoPPTs)
x <- window(SanMartinoPPTs, end=as.Date("1930-12-31"))

## Plotting the daily ts only, and then automatic 'x' axis
plot(x, xaxt = "n", xlab="Time")
drawTimeAxis(x)

## Plotting the daily ts only, and then monthly ticks in the 'x' axis,
## with annual labels.
plot(x, xaxt = "n", xlab="Time")
drawTimeAxis(x, tick.tstep="months", lab.tstep="years")
```
dwdays

Amount of dry/wet days in a time series

Description

Given a daily time series (usually precipitation), this function computes the average amount of wet/dry days in each month.

Usage

dwdays(x, ...)

## Default S3 method:
dwdays(x, thr=0, type="wet", na.rm=TRUE, ...)

## S3 method for class 'data.frame'
dwdays(x, thr=0, type="wet", na.rm=TRUE,
       dates=1, date.fmt="%Y-%m-%d", verbose=TRUE,...)

## S3 method for class 'matrix'
dwdays(x, thr=0, type="wet", na.rm=TRUE,
       dates=1, date.fmt="%Y-%m-%d", verbose=TRUE,...)

Arguments

x zoo, data.frame or matrix object, usually with daily time series of precipitation. Measurements at several gauging stations can be stored in a data.frame of matrix object, and in that case, each column of x represent the time series measured in each gauging station, and the column names of x have to correspond to the ID of each station (starting by a letter).

thr numeric. Value of daily precipitation used as threshold for classifying a day as dry/wet or not. Days with a precipitation value larger to thr are classified as wet days, whereas precipitation values lower to thr are classified as dry days.

type character, indicating if the daily values have to be classified as dry or wet days. It works linked to the values specified in thr. Valid values are: wet, dry.

na.rm Logical. Should missing values be removed before counting?

dates numeric, factor or Date object indicating how to obtain the dates
If dates is a number (default), it indicates the index of the column in x that stores the dates
If dates is a factor, it is converted into Date class, using the date format specified by date.fmt
If dates is already of Date class, the code verifies that the number of days in dates be equal to the number of element in x
date.fmt character indicating the format in which the dates are stored in dates, e.g. %Y-%m-%d.
See format in \texttt{as.Date}.
ONLY required when \texttt{class(dates)}="factor" or \texttt{class(dates)}="numeric".

verbose logical; if \texttt{TRUE}, progress messages are printed

... further arguments passed to or from other methods.

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>.

Examples

\begin{verbatim}
## Loading the SanMartino precipitation data
data(SanMartinoPpts)
x <- SanMartinoPpts

## Average amount of wet days in each month (for this example, this means days
## with precipitation larger than 0.1mm)
dwdays(x, thr=0.1)
\end{verbatim}

\section*{dwi Days with Information}

Description

This function generates a table indicating the number of days with information (<>NA) within a
zoo object, aggregated by year, month or month per year.

Usage

dwi(x, ...)

\begin{verbatim}
## Default S3 method:
dwi(x, out.unit = "years", from = start(x), to = end(x),
date.fmt = "%Y-%m-%d", tstep="days", ...)

## S3 method for class 'zoo'
dwi(x, out.unit = "years", from = start(x), to = end(x),
date.fmt = "%Y-%m-%d", tstep="days", ...)

## S3 method for class 'data.frame'
dwi(x, out.unit = "years", from, to, date.fmt = "%Y-%m-%d", tstep="days",
dates = 1, verbose = TRUE, ...)

## S3 method for class 'matrix'
dwi(x, out.unit = "years", from, to, date.fmt = "%Y-%m-%d", tstep="days",
dates = 1, verbose = TRUE, ...)
\end{verbatim}
Arguments

x  zoo, data.frame or matrix object, with daily/monthly/annual time series.
    Measurements at several gauging stations can be stored in a data.frame of matrix
    object, and in that case, each column of x represent the time series measured in
    each gauging station, and the column names of x have to correspond to the ID
    of each station (starting by a letter).

out.unit  aggregation time for the computation of the amount of days with information.
    Valid values are:
    - months: monthly;
    - years : annual;
    - mpy : month per year (not available for data.frames)

from  Character indicating the starting date for the computations. It has to be in the
    format indicated by date.fmt.
    When x is a data.frame and this value is not provided, the date corresponding to
    the first row of x is used

to  Character indicating the ending date for the computations. It has to be in the
    format indicated by date.fmt.
    When x is a data.frame and this value is not provided, the date corresponding to
    the last row of x is used

date.fmt  character indicating the format in which the dates are stored in dates, e.g. %Y-%m-%d.
    See format in as.Date.
    ONLY required when class(dates)=="factor" or class(dates)=="numeric".

tstep  Time step used for storing the values in x. Valid values are: days, months, 
    years. Since the version 0.3-0 of hydroTSM, this argument is not required any
    more, because it is not used any longer.

dates  numeric, factor or Date object indicating how to obtain the dates for each column
    of x
    If dates is a number, it indicates the index of the column in x that stores the
    dates
    If dates is a factor, it is converted into Date class, using the date format specified
    by date.fmt
    If dates is already of Date class, the code verifies that the number of days in
    dates be equal to the number of element in x

verbose  logical; if TRUE, progress messages are printed

...  further arguments passed to or from other methods.

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>
Examples

```r
## Loading the SanMartino precipitation data
data(SanMartinoPpts)
x <- SanMartinoPpts

## Days with information per year
dwi(x)

## Days with information per month per year.
dwi(x, out.unit="mpy")

########
## Not run:
## Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPptsMonthly)

## Months with information per year in the 9 first stations of 'EbroPptsMonthly'
a <- dwi(EbroPptsMonthly[,1:10], out.unit="years", dates=1)

## Before plotting the results in 'a', and just for obtaining a more interesting
## plot, 70 random numbers (between 1 and 11) are introduced in 'a'
a[sample(length(a), size = 70)] <- rep(1:11, length=70)

## Plotting the amount of months with information per year in each station
matrixplot(a, var.type="Days", main="Number of months with info per year")

## End(Not run)
```

---

### Description

Shapefile with 57 subcatchments of the Ebro River basin (Spain)

### Usage

```r
data(EbroCatchmentsCHE)
```

### Format

SpatialPolygonsDataFrame-class.

The fields stored in the @data slot of this object are:

- `CUECHE`: sequential counter  
- `CUECHE_ID`: ID of each subcatchment  
- `NOMBRE`: name of each subcatchment  
- `AREA_KM2`: area of each subcatchment, [km2]
Details

Projection: European Datum 50, Zone 30N.

Note

A small subcatchment of 0.3 km2 was removed of the original shapefile, due to the fact that it did not have name and it was too small for the purposes of this dataset.

Source

Downloaded ('Divisorias Hidrograficas 1:50.000 - CHE') from the web site of the Confederacion Hidrografica del Ebro (CHE) http://oph.chebro.es/ContenidoCartoHidrologia.htm. Last accessed [March 2008]. These data are intended to be used for research purposes only, being distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY.
EbroPPgis  
Spatial location of raingauges on the Ebro River basin

Description
Spatial location of the 349 raingauges with daily precipitation on the Ebro River Basin (dataset 'EbroPPts'), Spain, with more than 70% of days with information (without missing values)

Usage
data(EbroPPgis)

Format
A data.frame with seven fields:
*) 'ID': identifier of each gauging station.
*) 'STATION_NAME': name of the gauging station.
*) 'EAST_ED50': easting coordinate of the gauging station. European Datum 50, Zone 30 North.
*) 'NORTH_ED50': northing coordinate of the gauging station. European Datum 50, Zone 30 North.
*) 'ELEVATION': elevation of the gauging station, [m a.s.l.].
*) 'CHE_BASIN_ID': identifier of the subbasin in which the gauging station is located.
*) 'CHE_BASIN_NAME': name of the subbasin in which the gauging station is located.

Details
Projection: European Datum 50, Zone 30N.

Source
Downloaded ('Red de Control Meteorologico') from the web site of the Confederacion Hidrografica del Ebro (CHE) http://oph.chebro.es/ContenidoCartoClimatologia.htm. Last accessed [March 2008], and then the name of 7 selected fields were translated into English language.

These data are intended to be used for research purposes only, being distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY.

EbroPPtsMonthly  
Ebro Monthly Precipitation Time Series

Description
Usage
data(EbroPPtsMonthly)

Format
A data.frame with 331 monthly time series, plus the first field storing the dates corresponding to
each row.

Details
Monthly time series of precipitation on 331 stations of the Ebro River basin (Spain), where some
data were in-filled by using the MOSS method and from daily time series used in the technical
report "Estudio de Recursos de la Cuenca del Ebro".

Source
Downloaded from the web site of the Confederacion Hidrografica del Ebro (CHE) http://oph.chebro.es/DOCUMENTACION/PrecipitacionMensualRelleno/PrecipitacionMensualRelleno.html. Last accessed [March 2010].
These data are intended to be used for research purposes only, being distributed in the hope that it
will be useful, but WITHOUT ANY WARRANTY.

extract Extract from Zoo

Description
Extracts from a zoo object all the values belonging to a given month, year or weather season.

Usage
extract(x, ...)

## Default S3 method:
exttract(x, trgt, ...)

## S3 method for class 'zoo'
extact(x, trgt, ...)

Arguments

<table>
<thead>
<tr>
<th>x</th>
<th>zoo object</th>
</tr>
</thead>
</table>
| trgt  | numeric or character indicating the elements to extract from x. Valid values are:
|       | 1) integer from 1 to 12: trgt is considered as a month (1=JAN, 2=FEB......, 12=DEC), and all the values in x belonging to the month specified by trgt will be extracted.
|       | 2) integer > 12: trgt is considered as a year, and all the values in x belonging |
Computes and plots the Flow Duration Curve (FDC) corresponding to a given time series of stream-flow discharges.
Usage

```r
 usage <- c("default", "method")

# Default S3 method:
fdc(x, lQ.thr=0.7, hQ.thr=0.2, plot=TRUE, log="y",
     main="Flow Duration Curve", xlab="% Time flow equalled or exceeded",
     ylab="Q, [m3/s]", ylim, yat=c(0.01, 0.1, 1), xat=c(0.01, 0.025, 0.05),
     col=palette("default")[1:ncol(x)], pch=1:ncol(x), lwd=rep(1, ncol(x)),
     lty=1:ncol(x), cex=0.4, cex.axis=1.2, cex.lab=1.2, leg.txt=NULL, leg.cex=1,
     leg.pos="topright", verbose= TRUE, thr.shw=TRUE, new=TRUE, ...)

# S3 method for class 'matrix'
fdc(x, lQ.thr=0.7, hQ.thr=0.2, plot=TRUE, log="y",
     main="Flow Duration Curve", xlab="% Time flow equalled or exceeded",
     ylab="Q, [m3/s]", ylim, yat=c(0.01, 0.1, 1), xat=c(0.01, 0.025, 0.05),
     col=palette("default")[1:ncol(x)], pch=1:ncol(x), lwd=rep(1, ncol(x)),
     lty=1:ncol(x), cex=0.4, cex.axis=1.2, cex.lab=1.2, leg.txt=NULL, leg.cex=1,
     leg.pos="topright", verbose=TRUE, thr.shw=TRUE, new=TRUE, ...)

# S3 method for class 'data.frame'
fdc(x, lQ.thr=0.7, hQ.thr=0.2, plot=TRUE, log="y",
     main="Flow Duration Curve", xlab="% Time flow equalled or exceeded",
     ylab="Q, [m3/s]", ylim, yat=c(0.01, 0.1, 1), xat=c(0.01, 0.025, 0.05),
     col=palette("default")[1:NCOL(x)], pch=1:NCOL(x), lwd=rep(1, NCOL(x)),
     lty=1:NCOL(x), cex=0.4, cex.axis=1.2, cex.lab=1.2, leg.txt=NULL, leg.cex=1,
     leg.pos="topright", verbose=TRUE, thr.shw=TRUE, new=TRUE, ...)

# S3 method for class 'zoo'
fdc(x, lQ.thr=0.7, hQ.thr=0.2, plot=TRUE, log="y",
     main="Flow Duration Curve", xlab="% Time flow equalled or exceeded",
     ylab="Q, [m3/s]", ylim, yat=c(0.01, 0.1, 1), xat=c(0.01, 0.025, 0.05),
     col=palette("default")[1:NCOL(x)], pch=1:NCOL(x), lwd=rep(1, NCOL(x)),
     lty=1:NCOL(x), cex=0.4, cex.axis=1.2, cex.lab=1.2, leg.txt=NULL, leg.cex=1,
     leg.pos="topright", verbose=TRUE, thr.shw=TRUE, new=TRUE, ...)
```

Arguments

- **x**
  - numeric, zoo, data.frame or matrix object with the observed streamflows for which the flow duration curve have to be computed.
  - Measurements at several gauging stations can be stored in a data.frame of matrix object, and in that case, each column of x represent the time series measured in each gauging station, and the column names of x have to correspond to the ID of each station (starting by a letter). When x is a matrix or data.frame, the flow duration curve is computed for each column.

- **lQ.thr**
  - numeric, low-flow separation threshold. If this value is different from NA, a vertical line is drawn in this value, and all the values to the left of it are deemed low flows.
numeric, high-flow separation threshold. If this value is different from NA, a vertical line is drawn in this value, and all the values to the right of it are deemed high flows.

plot logical. Indicates if the flow duration curve should be plotted or not. Default value is TRUE.

log character, indicates which axis has to be plotted with a logarithmic scale. Default value is y

main See plot. An overall title for the plot: see title.

xlab A title for the x axis. See plot.

ylab A title for the y axis. See plot.

ylim The y limits of the plot. See plot.default.

yat numeric, with points at which tick-marks will try to be drawn in the Y axis, in addition to the defaults computed by R. See the at argument in Axis.

xat Only used when log="x".

numeric, with points at which tick-marks will try to be drawn in the x axis, in addition to the defaults computed by R. See the at argument in Axis.

col The colors to be used for lines and points. Multiple colors can be specified so that each point can be given its own color. If there are fewer colors than points they are recycled in the standard fashion. Lines will all be plotted in the first colour specified. See plot.default.

pch A vector of plotting characters or symbols: see points. See plot.default.

lwd The line width, see par. See plot.default.

lty The line type, see par. See plot.default.

cex See plot.default. A numerical vector giving the amount by which plotting characters and symbols should be scaled relative to the default. This works as a multiple of par("cex"). 'NULL' and 'NA' are equivalent to '1.0'. Note that this does not affect annotation

cex.axis magnification of axis annotation relative to 'cex'.

cex.lab Magnification to be used for x and y labels relative to the current setting of 'cex'. See '?par'.

leg.txt vector with the names that have to be used for each column of x.

leg.cex numeric, indicating the character expansion factor for the legend, *relative* to current par("cex"). Default value = 1

leg.pos keyword to be used to position the legend. One of the list ""bottomright", "bottom", "bottomleft", "left", "topleft", "top", "topright", "right", "center"". This places the legend on the inside of the plot frame at the given location. See legend.

verbose logical; if TRUE, progress messages are printed (when x is a matrix or data.frame).

thr.shw logical, indicating if the streamflow values corresponding to the user-defined thresholds lQ, thr and hQ, thr have to be shown in the plot.

new logical, if TRUE (default), a new plotting window is created.

... further arguments passed to or from other methods (to the plotting functions)
**Value**

numeric, matrix or data.frame whose columns contains the % of time each one of the streamflow magnitudes given as input was equalled or exceeded. The resulting values have to be multiplied by 100 to get a percentage.

When `plot` is TRUE (default), the resulting flow duration curve is plotted in a new window.

**Author(s)**

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

**References**


**See Also**

`fdcu`

**Examples**

```r
## Loading daily streamflows at the station Oca en Ona (Ebro River basin, Spain) ##
data(OcaEnOnaQts)

## Daily Flow Duration Curve
fdc(OcaEnOnaQts)

##############################
# Comparing 2 FDCs:
x <- OcaEnOnaQts

# Random 2nd ts
y <- x + rnorm(length(x), mean=10)

# data.frame with the 2 time series
xx <- data.frame(x=x, y=y)

# FDC plot
fdc(xx, thr.shw=FALSE)
```
Description

Computes and plots the Flow Duration Curve (FDC) for the streamflows given by \(x\) and for two uncertainty bounds, with the possibility of plotting an additional FDC representing simulated streamflows for \(x\), in order to compare them.

Usage

```r
fdcu(x, lband, uband, ...) 
```

### Default S3 method:
```
fdcu(x, lband, uband, sim, lq.thr=0.7, hq.thr=0.2, plot=TRUE, log="y", main="Flow Duration Curve", xlab="% Time flow equalled or exceeded", ylab="Q [m3/s]", ylim, yat=c(0.01, 0.1, 1), xat=c(0.01, 0.025, 0.05), col=c("black", "red"), pch=c(1, 15), lwd=c(1, 0.8), lty=c(1, 3), cex=0.2, cex.axis=1.2, cex.lab=1.2, leg.txt= c("Qobs", "Qsim", "95PPU"), leg.cex=1, leg.pos="auto", verbose= TRUE, thr.shw=TRUE, border=NA, bands.col="lightcyan", bands密度= NULL, bands.angle=45, new=TRUE, ...)
```

### S3 method for class 'matrix'
```
fdcu(x, lband, uband, sim, lq.thr=0.7, hq.thr=0.2, plot=TRUE, log="y", main="Flow Duration Curve", xlab="% Time flow equalled or exceeded", ylab="Q [m3/s]", ylim, yat=c(0.01, 0.1, 1), xat=c(0.01, 0.025, 0.05), col=matrix(c(rep("black", ncol(x))), palette("default")[2:(ncol(x)+1)]), byrow=FALSE, ncol=2), pch=matrix(rep(c(1, 15), ncol(x)), byrow=TRUE, ncol=2), lwd=matrix(rep(c(1, 0.8), ncol(x)), byrow=TRUE, ncol=2), lty=matrix(rep(c(1, 3), ncol(x)), byrow=TRUE, ncol=2), cex=rep(0.1, ncol(x)), cex.axis=1.2, cex.lab=1.2, leg.txt= c("obs", colnames(x), "95PPU"), leg.cex=1, leg.pos="auto", verbose= TRUE, thr.shw=TRUE, border=rep(NA, ncol(x)), bands.col=rep("lightcyan", ncol(x)), bands密度= rep(NULL, ncol(x)), bands.angle=rep(45, ncol(x)), new=TRUE, ...)
```

### S3 method for class 'data.frame'
```
fdcu(x, lband, uband, sim, lq.thr=0.7, hq.thr=0.2, plot=TRUE, log="y", main="Flow Duration Curve", xlab="% Time flow equalled or exceeded", ylab="Q [m3/s]", ylim, yat=c(0.01, 0.1, 1), xat=c(0.01, 0.025, 0.05), col=matrix(c(rep("black", ncol(x))), palette("default")[2:(ncol(x)+1)]), byrow=FALSE, ncol=2), pch=matrix(rep(c(1, 15), ncol(x)), byrow=TRUE, ncol=2), lwd=matrix(rep(c(1, 0.8), ncol(x)), byrow=TRUE, ncol=2), lty=matrix(rep(c(1, 3), ncol(x)), byrow=TRUE, ncol=2), cex=rep(0.1, ncol(x)), cex.axis=1.2, cex.lab=1.2,
```
Arguments

x numeric, zoo, data.frame or matrix object with the observed streamflows for which the flow duration curve have to be computed. Measurements at several gauging stations can be stored in a data.frame of matrix object, and in that case, each column of x represent the time series measured in each gauging station, and the column names of x have to correspond to the ID of each station (starting by a letter). When x is a matrix or data.frame, the flow duration curve is computed for each column.

lband numeric, zoo, data.frame or matrix object with the streamflows representing the the lower uncertainty bound of x, for which the flow duration curve have to be computed. Measurements at several gauging stations can be stored in a data.frame of matrix object. When lband is a matrix or data.frame, the flow duration curve is computed for each column.

uband numeric, zoo, data.frame or matrix object with the streamflows representing the the upper uncertainty bound of x, for which the flow duration curve have to be computed. Measurements at several gauging stations can be stored in a data.frame of matrix object. When uband is a matrix or data.frame, the flow duration curve is computed for each column.

dim OPTIONAL. numeric, zoo, data.frame or matrix object with the streamflows simulated for x, for which the flow duration curve have to be computed. Measurements at several gauging stations can be stored in a data.frame of matrix object. When dim is a matrix or data.frame, the flow duration curve is computed for each column.

lQ.thr numeric, low flows separation threshold. If this value is different from 'NA', a vertical line is drawn in this value, and all the values to the left of it are deemed low flows.

hQ.thr numeric, high flows separation threshold. If this value is different from 'NA', a vertical line is drawn in this value, and all the values to the right of it are deemed high flows.

plot logical. Indicates if the flow duration curve should be plotted or not.

log character, indicates which axis has to be plotted with a logarithmic scale. Default value is y.

main See plot. An overall title for the plot: see title.

xlab See plot. A title for the x axis: see title.

ylab See plot. A title for the y axis: see title.

ylim See plot.default. The y limits of the plot.
yat

Only used when log="y".
numeric, with points at which tick-marks will try to be drawn in the Y axis, in addition to the defaults computed by R. See the at argument in Axis.

xat

Only used when log="x".
numeric, with points at which tick-marks will try to be drawn in the x axis, in addition to the defaults computed by R. See the at argument in Axis.

col

See plot.default. The colors for lines and points. Multiple colors can be specified so that each point can be given its own color. If there are fewer colors than points they are recycled in the standard fashion. Lines will all be plotted in the first colour specified.

pch

See plot.default. A vector of plotting characters or symbols: see points.

lwd

See plot.default. The line width, see par.

lty

See plot.default. The line type, see par.

cex

See plot.default. A numerical vector giving the amount by which plotting characters and symbols should be scaled relative to the default. This works as a multiple of par("cex"). 'NULL' and 'NA' are equivalent to '1.0'. Note that this does not affect annotation.

cex.axis

magnification of axis annotation relative to 'cex'.

cex.lab

Magnification to be used for x and y labels relative to the current setting of 'cex'. See '?par'.

leg.txt

vector with the names that have to be used for each column of x.

leg.cex

numeric, indicating the character expansion factor for the legend, *relative* to current par("cex"). Default value = 1

leg.pos

keyword to be used to position the legend. One of the list "bottomright", "bottom", "bottomleft", "left", "topleft", "top", "topright", "right", "center". This places the legend on the inside of the plot frame at the given location. See legend.
When leg.pos="auto", the legend provided by leg.txt is located on the 'bottomleft' when log="y" and on the 'topright' otherwise.

verbose

logical; if TRUE, progress messages are printed

thr.shw

logical, indicating if the streamflow values corresponding to the user-defined thresholds lq, thr and hq, thr have to be shown in the plot.
When leg.pos="auto", the legend with the threshold values is located on the 'topright' when log="y" and on the 'bottomleft' otherwise.

border

See polygon. The color to draw the border of the polygon with the uncertainty bounds. The default, 'NA', means to omit borders.

bands.col

See polygon. The color for filling the polygon. The default, 'NA', is to leave polygons unfilled, unless bands.density is specified. If bands.density is specified with a positive value this gives the color of the shading lines.

bands.density

See polygon. The density of shading lines for the polygon with the uncertainty bounds, in lines per inch. The default value of 'NULL' means that no shading lines are drawn. A zero value of bands.density means no shading nor filling whereas negative values (and 'NA') suppress shading (and so allow color filling).
bands.angle See polygon. The slope of shading lines for the polygon with the uncertainty bounds, given as an angle in degrees (counter-clockwise).

new logical, if TRUE, a new plotting window is created.

... further arguments passed to or from other methods (to the plotting functions)

Note

If you do not want to use logarithmic scale for the streamflow axis, you can do it by passing the log="" to the ... argument.

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

References


See Also

fdc

Examples

## Loading daily streamflows at the station Oca en Ona (Ebro River basin, Spain) ##
data(OcaEnOnaQts)
q <- OcaEnOnaQts

# Creating a fictitious lower uncertainty band
lband <- q - min(q, na.rm=TRUE)

# Giving a fictitious upper uncertainty band
uband <- q + mean(q, na.rm=TRUE)

# Plotting the flow duration curve corresponding to 'q', with two uncertainty bounds
fdcu(q, lband, uband)
Description

Given a data.frame \((x.g\text{is})\) with the spatial coordinates of a set of measurement points (e.g., gauging stations) and the measurements in those stations \((x.t\text{s})\) this function merges the measurements in \(x.t\text{s}\) with the corresponding spatial location in \(x.g\text{is}\), even if they are not in the same order.

If the spatial coordinates \(X\) and \(Y\) are given for \(x.g\text{is}\), the resulting object will be a `SpatialPointsDataFrame`-class with coordinates given by the \(X\) and \(Y\) fields.

If \(p4s\) is given, the resulting object will be projected according to the specification provided by \(p4s\).

Usage

\[
gists2spt(x.g\text{is}, x.t\text{s}, sname, bname, X, Y, elevation, catchment.name="all", na.rm=TRUE, p4s)\]

Arguments

\(x.g\text{is}\) data.frame with the spatial information for all the measurement points in \(x.g\text{is}\). The name of each station, stored in the field \(sname\), have to be equal to the corresponding ID used in \(x.t\text{s}\)

\(-\) It MAY contain as many measurement points as you want, e.g., all the gauging stations in your database, but

\(-\) It HAVE TO contain -at least- the location of the measurement points of \(x.t\text{s}\) that will be used for the interpolations.

The MINIMUM fields that HAVE TO be present in this file, and their corresponding column index are \(X\), \(Y\), \(sname\).

\(x.t\text{s}\) numeric or data.frame with the measured value at each station for a given time.

Each value of \(x.t\text{s}\) has to have as name \((\text{names}(x.t\text{s})\) the ID of the station.

1) It MAY contain as many stations as you want, e.g., all the gauging stations in the your database, but

2) It HAVE TO contain -at least- some stations of \(x.g\text{is}\)

\(sname\) character, field name in \(x.g\text{is}\) that stores the name of the stations (the name of the stations have to start by a letter !!)

\(bname\) OPTIONAL character, field name in \(x.g\text{is}\) that stores the name of the sub-catchment in \(x.g\text{is}\) that will be analysed.

ONLY necessary when 'catchment.name' is not "all"

\(X\) character, field name in \(x.g\text{is}\) that stores the easting coordinate of the measurement points. The expected name is 'x', but if the value provided by the user is different, a new 'x' field is created and is used as the easting coordinate of \(x.g\text{is}\)
character, field name in `x.gis` that stores the northing coordinate of the measurement points. The expected name is 'y', but if the value provided by the user is different, a new 'y' field is created and is used as the northing coordinate of `x.gis`.

**elevation**

OPTIONAL. character, field name in `x.gis` that stores the elevation of the stations (m a.s.l.).

**catchment.name**

name of the catchment that will be analysed. Possible values are:

- `all`: ALL the stations in the `x.gis` will be used
- `other character`: ONLY those stations in `x.gis` with a `bname` field value == `catchment.name` will be used.

**p4s**

Character with information about the projection of the GIS files, usually created by the CRS function of the `sp` package.

**na.rm**

a logical value indicating whether 'NA' values should be stripped before delivering the resulting object.

### Value

If `p4s` is given, the returning object will be a `SpatialPointsDataFrame-class`, if not, it will be a `data.frame`.

### Author(s)

Mauricio Zambrano-Bigiarini, `<mzb.devel@gmail>`

### References


[http://r-spatial.sourceforge.net/gallery/](http://r-spatial.sourceforge.net/gallery/)

### See Also

`krige`, `spplot`

### Examples

```
# Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPPtsMonthly)

# Loading the gis data
data(EbroPPgis)

# Putting the measurements of the first row of 'EbroPPtsMonthly' into their corresponding spatial location given by 'x.gis'
require(sp)
x.spt <- gists2spt(x.ts=EbroPPtsMonthly[1,], x.gis=EbroPPgis, X="EAST_ED50", Y="NORTH_ED50", na.rm=FALSE, sname="ID")
```
### Description

Given any starting and ending date/time objects, it generates:
1) a vector of class c("POSIXct" "POSIXt") with all the hours between the two date/time objects (both of them included), OR
2) the amount of hours between the two date/time objects

### Usage

```r
hip(from, to, date.fmt="%Y-%m-%d %H", out.type = "seq")
```

### Arguments

- **from**: Character or POSIXct object indicating the starting date/time for creating the sequence. It has to be in the format indicated by `date.fmt`.
- **to**: Character indicating the ending date/time for creating the sequence. It has to be in the format indicated by `date.fmt`.
- **date.fmt**: character indicating the format in which the date/time objects are stored in `from` and `to`, e.g. `%Y-%m-%d %H:%M`. See format in `as.Date`. ONLY required when `class(dates)=="factor"` or `class(dates)=="numeric"`.
- **out.type**: Character indicating the type of result that is given by this function. Valid values are:
  1) `seq`: a vector of class `Date` with all the days between the two dates, OR
  2) `nmbr`: a single numeric value with the amount of days between the two dates.

### Value

Depending on the value of `out.type`, it returns:
1) a vector of class c("POSIXct" "POSIXt") with all the hours between `from` and `to` (both of them included), OR
2) the amount of hours between the two date/time objects

### Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>
Examples

```r
# Sequence of hours between "1961-01-01 00:00" and "1961-01-10 00:00", giving the
# starting and ending date/time objects with hours and skipping the minutes (default)
hip("1961-01-01 00", "1961-12-31 00")

# Sequence of hours between "1961-01-01 00:00" and "1961-01-10 00:00", giving the
# starting and ending date/time objects only with hours and minutes (skipping the minutes)
hip("1961-01-01 00:00", "1961-12-31 00:00", date.fmt="%Y-%m-%d %H")

# Number of hours between the 10:00 AM of "1961-Jan-02" and the 11:00 AM of "1961-Jan-01",
# using "%d/%m/%Y" as date/time format.
hip("01/01/1961 10", "02/01/1961 11", date.fmt = "%d/%m/%Y %H", out.type = "nmb")
```

## hydrokrige

**Krige for Hydrological Time Series**

### Description

Automatic interpolation for hydrological ts, with optional plot (wrapper to some functions of the
**gstat** and **automap** packages)

Originally it was thought as a way to make easier the computation of average precipitation over
subcatchments (given as input in a shapefile map), based on values measured at several gauging
stations, but nowadays it can also be used for interpolating any variable over a grid given by a raster
map.

Available algorithms: inverse distance weighted (**IDW**), ordinary kriging (**OK**) and kriging with external drift (**KED**)

The (Block) Inverse Distance Weighted (**IDW**) interpolation is a wrapper to the **idw** function of the
**gstat** package (so, it requires the **gstat** package).

The automatic kriging (**OK** or **KED**) is a wrapper to the **autoKrige** function of the **automap** package
(so, it requires the **automap** and **gstat** packages), which automatically selects the best variogram
model from four different ones: spherical, exponential, gaussian and Matern with M. Stein’s parameterization (for more details, see **autoKrige**)

### Usage

```r
hydrokrige(x.ts, x.gis, ...)
```

## hydrokrige

### Default S3 method:

```r
hydrokrige(x.ts, x.gis, X = "x", Y = "y", sname, bname,
   elevation, predictors, catchment.name = "all", type="cells",
   formula, subcatchments, IDvar = NULL,
}```
**Arguments**

**x.ts**
- numeric or data.frame object, with measured values at several locations.
  - `x.ts` CAN contain as many points as you want, e.g., all the gauging stations in your database.
  - 2) `x.ts` HAVE to contain -at least- some points (e.g., gauging stations) that are also present in `x.gis`

The names of each value in `x.ts` are used as the ID of each measurement point. When `x.ts` is a vector, this can be checked with `names(x)`, whereas when `x.ts` is a data.frame, it can be checked with `colnames(x.ts)`. The IDs of each measurement point have to be equal to the ID stored in the field `sname` of `x.gis`.

When `x.ts` is a data.frame, its structure have to be as follow:
- 1st column : OPTIONAL. It MAY contain the dates, date-time or IDs that identify the measured values of each row. See dates argument.
- 2nd...Nth column: Measured values at each point (e.g., gauging station). The name of the columns is used as the ID of each station **-starting with a letter!!-**.

**x.gis**
- data.frame with the spatial information for each measurement point (e.g., gauging stations).
  - `x.gis` MAY contain as many points as you want, e.g., all the stations in your database
  - `x.gis` HAVE to contain -at least- the location of those stations that will be
used for the interpolations

The MINIMUM fields that have to be present in this file, and their corresponding column index are those described by: X, Y, sname.

The ID of each measurement point, given in the field sname, has to be equal to the corresponding ID used in x.ts

X character, field name in x.gis that stores the easting coordinate of each measurement point.

Y character, field name in x.gis that stores the northing coordinate of each measurement point.

sname character, field name in x.gis that stores the ID of each measurement point. the name of each measurement point HAS to start by a letter!!-

bname OPTIONAL. character, field name in x.gis that stores the name of the sub-catchment in x.gis that will be analysed. ONLY necessary when catchment.name is different from all.

elevation OPTIONAL. character, field name in x.gis that stores the elevation of the gauging stations (m a.s.l.).

predictors OPTIONAL. SpatialGridDataFrame-class object, with prediction/simulation locations (it is needed for KED). Usually, a digital elevation model (DEM) read with the readgdal function of the rgdal package. See the newdata argument in krige. It should contain attribute columns with the independent variables (if present) and the coordinates with names as defined in x.gis. If predictors is missing, the grid to be used as prediction/simulation locations is generated from sampling the polygon specified by the user in subcatchments, according to the arguments provided by cells.size and grid.type

catchment.name name of the catchment that will be analysed. Possible values are:
- all: ALL the stations in the x.gis will be used
- other string: ONLY those stations in x.gis with a bname field value equal to catchment.name will be used.

type Character, indicating the type of interpolation required by the user. When x.ts is a data.frame, the ONLY possible value is block. For all the other cases, possible values are:
- cells: the interpolated values are computed for each cell
- block: the interpolated values are computed for each subcatchment, where the value for each subcatchment is computed as the mean value over all the cells that belong to each subcatchment
- both: cells and block are computed.

formula OPTIONAL. Formula to be used in case of ordinary kriging or kriging with external drift. Requires the automap package. All the variables to be used within formula has to be present both in x.gis and predictors. See the formula argument in krige. formula defines the dependent variable as a linear model of independent variables. Within this function, the dependent variable is always called value,
therefore, for ordinary and simple kriging use the formula value~1; for simple
kriging also define beta; for universal kriging, suppose value is linearly
dependent on x and y, use the formula value~x+y.

subcatchments  OPTIONAL. Only required when predictors is missing.
Spatial polygon with all the subcatchments to be used as interpolation domain.
The polygons are used to create the grid that will be used as prediction/simulation
locations, from sampling it according to the arguments provided by cells.size and
grid.type. Valid values are:
1) Character, indicating the filename (with path) of the shapefile that contains
all the subcatchments to be used as interpolation domain. It HAS TO BE of
'polygon' type
2) SpatialPolygonsDataFrame-class resulting from reading the shapefile (e.g.,
with the command readShapePoly of the maptools package) that contains
all the subcatchments to be used as interpolation domain.

IDvar  See readShapePoly. a character string with the name of a field in the subcatchments
shapefile containing the ID values used to identify each one of the subcatch-
ments. When type is block, the values stored in this field will be used for
labelling the computed values in each one of the subcatchments, therefore, if
you don’t provide this value, it could be difficult to identify which computed
value corresponds to which subcatchment, because the ID is assigned by the
readShapePoly function.

p4s  OPTIONAL. a character with information about the projection of the GIS files,
usually created by the CRS function of the sp package.

cell.size  OPTIONAL. Only required when predictors is missing. Size of the cells [m]
to be used for sampling the polygons specified by the user in subcatchments,
to create a grid to be used as prediction/simulation locations .

grid.type  OPTIONAL. Only required when predictors is missing. See spsample. Char-
acter, indicating the type of grid to be computed over the area defined by subcatchments.
Valid values are:
- regular : for regular (systematically aligned) sampling; Default option
- random : for completely spatial random;
- stratified : for stratified random (one single random location in each "cell"
- nonaligned : for non-aligned systematic sampling (nx random y coordinates,
  ny random x coordinates);
- hexagonal : for sampling on a hexagonal lattice;
- clustered : for clustered sampling

nmin  OPTIONAL. See krig. For local interpolation: if the number of nearest ob-
servations within distance maxdist is less than nmin, a missing value will be
generated; see maxdist. By default nmin=0.

nmax  OPTIONAL. See krig. For local interpolation: the number of nearest ob-
servations that should be used for a kriging prediction, where nearest is defined in
terms of the space of the spatial locations. By default, all observations are used.

maxdist  OPTIONAL. See krig. For local interpolation: only observations within a
distance of maxdist from the prediction location are used for prediction or sim-
ulation; if combined with nmax, both criteria apply. By default, all observations
are used.
ColorRamp  Function defining the colour ramp to be used for plotting the maps OR character representing the colours to be used in the plot. In the latter case, valid values are in: c('Precipitation', 'Temperature', 'PCPAnomaly', 'PCPAnomaly2', 'TEMPAnomaly', 'TEMPPAnomaly').

plot  Logical, indicating if the interpolated values have to be plotted or not.

col.nintv  integer, number of colours that have to be used for plotting the interpolated values.

col.at  Specify at which interpolated values colours change. Valid values are:
- ) R : uses the default setting of spplot
- ) numeric: vector of reals giving the exact values in which the colors have to change. Useful when the user desires the same color for the same value when comparing to maps with different range of values.
- ) auto : default option.

at  <- seq(min, max, length.out=col.nintv)

min  <- floor(min(idw["var1.pred"]@data, na.rm=TRUE))

max  <- ceiling(max(idw["var1.pred"]@data, na.rm=TRUE))

main  Character with the title to be used for the plot.

stations.plot  Logical, indicating if the gauging stations, defined by x.gis have to be plotted.

stations.offset  2D list with the numeric coordinates in which the label with the amount of gauging stations have to be plotted. e.g., stations.offset = c(450000, 460000).

arrow.plot  Logical, indicating if a North Arrow have to be plotted.

arrow.offset  2D list with the numeric coordinates in which the north arrow has to be plotted. e.g., arrow.offset = c(600000, 4760000).

arrow.scale  Scale (in the map units) to be used for plotting the north arrow, e.g., scale = 20000

scalebar.plot  Logical, indicating if a Scale Bar has to be plotted.

sb.offset  2D list with the numeric coordinates in which the North Arrow has to be plotted. e.g., sb.offset = c(400000, 4490000).

sb.scale  Scale (in the map units) to be used for plotting the Scale Bar, e.g., scale = 100000, means that the scale bar will have a length of 100km.

verbose  logical; if TRUE, progress messages are printed.

allNA.action  Action to be executed when all the values in x.ts are NA. Valid values are:
- ) "error": it will produce an error message. Default option
- ) a single numeric value that will replace all the NA values in x.ts, giving place to a map with a constant value. At your own risk!

dates  numeric, factor, or character object indicating how to obtain the ID (usually dates) that will be used to identify the interpolation carried out for each row of x.ts.

If dates is a single number (default), it indicates the index of the column in x.ts that stores the dates.

If dates is a factor or character vector, its values will be used as ID for the interpolations carried out in each row of x.ts.

from  Character indicating the starting date for the values stored in all the files that will be read.
to

write2disk  Logical. Indicates if we want to write the output into a CSV file. Default value is TRUE.

out.fmt  OPTIONAL, only needed when write2disk=TRUE. Character indicating the type of csv file to be written with the results. Valid values are csv and csv2. For more information, see write.table

fname  OPTIONAL. Character with the filename of the output file. Only needed when write2disk=TRUE

... further arguments passed to or from other methods. In particular, these further arguments are passed to the function idw (gstat package) OR autoKrige (automap package), depending on the value passed to formula (see 'details' below):
- for IDW, the arguments are passed to: idw(formula, locations, newdata, nmin, nmax, maxdist, NNN)
- for OK, KED, the arguments are passed to: autoKrige(formula, input_data, new_data, nmin, nmax, maxdist, NNN)

Details

The type of interpolation (IDW, OK, KED) is obtained from the argument formula:

- ) When formula is missing, an IDW interpolation, by calling the idw function in the gstat package, with formula = value~1.
- ) When formula = value~1, an OK interpolation, by calling the autoKrige function, with formula = value~1.
- ) When formula = value~pred1 + pred2 + ... , a KED interpolation, by calling the autoKrige function, with the formula specified by the user.

When type is block or both, a block interpolation is carried out for each subcatchment defined by subcatchments, so far, computing the average value over all the cells belonging to each subcatchment.

The automatic kriging is carried out by using a variogram generated automatically with the autofitVariogram function of the automap package.

Value

Cells  When type is cells, the output object is a SpatialPixelsDataFrame-class, which slot 'data' has two variables: 'var1.pred' and 'var1.var' with the predictions and its variances, respectively

Block  When type is block, the output object is a SpatialPolygonsDataFrame-class, which slot 'data' has four variables: 'x', 'y' with the easting and northing coordinate of the centroid of the catchments specified by subcatchments, and 'var1.pred' and 'var1.var' with the predictions and its variances, respectively
list(Cells, Block)

When type is both, the resulting object is a list, with the two elements previously described.

Note

IMPORTANT: It is your responsibility to check the validity of the fitted variogram !.

Author(s)

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References


http://www.gstat.org/

http://r-spatial.sourceforge.net/gallery/

See Also

krige, autoKrige, readShapePoly, spsample

Examples

# Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPPtsMonthly)

# Loading the gis data
data(EbroPPgis)

# Loading the shapefile with the subcatchments
data(EbroCatchmentsCHE)

# Projection for the Subcatchments file
# European Datum 50, Zone 30N
require(sp)
p4s <- CRS("+proj=utm +zone=30 +ellps=intl +units=m +no_defs")

# Selecting the first day of 'EbroPPtsMonthly' for all the stations.
# The first column of 'EbroPPtsMonthly' has the dates
x.ts <- as.numeric(EbroPPtsMonthly[1, 2:ncol(EbroPPtsMonthly)])
## Setting the name of the gauging stations
```r
names(x.ts) <- colnames(EbroPPtsMonthly[1:2, ncol(EbroPPtsMonthly)])
```

# 1) IDW interpolation and plot
## Probably you will need to resize your window
## Not run:
```r
x.idw <- hydrokrige(x.ts= x.ts, x.gis=EbroPPgis,
                     X="EAST_ED50", Y="NORTH_ED50", sname="ID", bname="CHE BASIN_NAME",
                     type="both",
                     subcatchments= EbroCatchmentsCHE,
                     cell.size= 3000,
                     ColorRamp= "Precipitation",
                     main= "IDW Precipitation on the Ebro")
```

## End(Not run)

# 2) Ordinary Kriging interpolation and plot, in catchments defined by a shapefile
## Probably you will need to resize your window
## Not run:
```r
x.ok <- hydrokrige(x.ts= x.ts, x.gis=EbroPPgis,
                    X="EAST_ED50", Y="NORTH_ED50", sname="ID", bname="CHE BASIN_NAME",
                    type="both", formula=value~1,
                    subcatchments= EbroCatchmentsCHE,
                    p4s= p4s,
                    cell.size= 3000,
                    ColorRamp= "Precipitation",
                    main= "OK Precipitation on the Ebro", arrow.plot= TRUE,
                    arrow.offset= c(900000, 4750000), arrow.scale= 20000,
                    scalebar.plot= TRUE,
                    sb.offset= c(400000, 4480000), sb.scale= 100000)
```

## End(Not run)

# 3) Ordinary Kriging interpolation and plot, in an area defined by a raster map.
## The raster map may be any `link{sp}{spatialgriddataframe-class} object, read with
## the `code{\link[rgdal](readGDAL)} function of the \pkg{rgdal} package or similar.
## Probably you will need to resize your window
```r
# Loading the DEM
data(EbroDEM1000m)

# Giving a meaningful name to the predictor
EbroDEM1000m$ELEVATION <- EbroDEM1000m$band1

# Saving memory
EbroDEM1000m$band1 <- NULL
```
# Computing OK, over the spatial grid defined by the DEM
## Not run:
x.ok <- hydrokrige(x.ts= x.ts, x.gis=EbroPPgis,
  X="EAST_ED50", Y="NORTH_ED50", sname="ID",
  formula=value~1,
  p4s=p4s,
  predictors=EbroDEM1000m,
  ColorRamp= "Precipitation",
  main= "OK Precipitation on the Ebro",
  arrow.plot= TRUE,
  arrow.offset= c(900000,4750000), arrow.scale= 20000,
  scalebar.plot= TRUE,
  sb.offset= c(400000,4480000), sb.scale= 10000)

## End(Not run)

########################################################################
## 4) Kriging with External Drift interpolation and plot
## Probably you will need to resize your window

# Loading the DEM
data(EbroDEM1000m)

# Giving a meaningful name to the predictor
EbroDEM1000m$ELEVATION <- EbroDEM1000m$band1

# Saving memory
EbroDEM1000m$band1 <- NULL

# Computing KED
## Not run:
x.ked <- hydrokrige(x.ts= x.ts, x.gis=EbroPPgis,
  X="EAST_ED50", Y="NORTH_ED50", sname="ID",
  bname="CHE_BASIN_NAME", elevation="ELEVATION",
  type= "cells",
  formula=value=ELEVATION,
  subcatchments= EbroCatchmentsCHE,
  predictors=EbroDEM1000m,
  cell.size= 3000,
  ColorRamp= "Precipitation",
  main= "KED Precipitation on the Ebro",
  arrow.plot= TRUE,
  arrow.offset= c(900000,4750000), arrow.scale= 20000,
  scalebar.plot= TRUE,
  sb.offset= c(400000,4480000), sb.scale= 10000)

## End(Not run)

########################################################################
## 5) Block IDW interpolation and plot of 'EbroPptsMonthly' for 3 months
## Not run:
x.idw <- hydrokrige(x.ts= EbroPptsMonthly, x.gis=EbroPPgis,
  X="EAST_ED50", Y="NORTH_ED50", sname="ID",
**Description**

Visualization of a correlation matrix. On top the (absolute) value of the correlation plus the result of the cor.test as stars. On bottom, the bivariate scatterplots, with a fitted line. On the diagonal, an histogram of each variable.

**Usage**

```r
hydropairs(x, dec = 3, use = "pairwise.complete.obs", method = "pearson", ...)
```

**Arguments**

- **x**: data.frame or matrix object with measurements at several locations. Each column of x represent values measured at different locations.
- **dec**: decimal places to be used for showing the correlation values
- **use**: See cor. An optional character string giving a method for computing covariances in the presence of missing values. This must be (an abbreviation of) one of the strings "everything", "all.obs", "complete.obs", "na.or.complete", or "pairwise.complete.obs".
- **method**: See cor. A character string indicating which correlation coefficient (or covariance) is to be computed. One of "pearson" (default), "kendall", or "spearman", can be abbreviated
- **...**: further arguments passed to or from other methods, in particular it is used in the pairs function.

**Value**

- **On top**: the (absolute) value of the correlation plus the result of the cor.test as points
- **On bottom**: the bivariate scatterplots, with a fitted line
- **On diagonal**: histograms (from pairs)
Note


Histogram panel was taken from the R help of the original pairs function

Author(s)

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See Also
cor, pairs

Examples

## Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPPtsMonthly)

## Visualizing the correlation among the monthly precipitation values
## of the first 3 gauging stations in 'EbroPPtsMonthly'.
## The first column of 'EbroPPtsMonthly' has the dates.
hydropairs(EbroPPtsMonthly[,2:4])

---

hydroplot

Hydrological time series plotting and extraction.

Description

hydroplot: When x is a zoo object it plots (a maximum of) 9 graphs (lines plot, boxplots and/or histograms) of the daily, monthly, annual and/or seasonal time series.

sname2plot: When x is a data frame whose columns contain the time series of several gauging stations, it takes the name of one gauging station and plots the graphs described above.

Usage

hydroplot(x, FUN, na.rm=TRUE, ptype="ts+boxplot+hist", pfreq="dma",
var.type, var.unit="units", main=NULL, xlab="Time", ylab,
win.len1=0, win.len2=0, tick.tstep="auto", lab.tstep="auto",
lab.fmt=NULL, cex=0.3, cex.main=1.3, cex.lab=1.3, cex.axis=1.3,
col=c("blue", "lightblue", "lightblue"),
from, to, date.fmt="%Y-%m-%d",
stype="default", season.names=c("Winter", "Spring", "Summer", "Autumn"),
h=NULL, ...)
sname2plot(x, sname, FUN, na.rm=TRUE, ptype="ts+boxplot+hist",
name2plot(x, sname, na.rm=TRUE, ptype="ts+boxplot+hist",
var.type, var.unit="units", xlab="Time", ylab,
win.len1=0, win.len2=0, tick.tstep="auto", lab.tstep="auto",
lab.fmt=NULL, cex=0.3, cex.main=1.3, cex.lab=1.3, cex.axis=1.3,
col=c("blue", "lightblue", "lightblue"),
from, to, date.fmt="%Y-%m-%d",
season.names=c("Winter", "Spring", "Summer", "Autumn"),
h=NULL, ...)
Arguments

x
zoo, xts or data.frame object, with columns storing the time series of one or more gauging stations.

sname
ONLY required when x is a data frame. Character representing the name of a station, which have to correspond to one column name in x

FUN
ONLY required when var.type is missing AND pfreq != "o". Function that have to be applied for transforming from daily to monthly or annual time step (e.g., For precipitation FUN=sum and for temperature and flow ts, FUN=mean)

na.rm
Logical. Should missing values be removed before the computations?

ptype
Character indicating the type of plot that will be plotted. Valid values are:
- ts = only time series
- ts+boxplot = only time series + boxplot
- ts+hist = only time series + histogram
- ts+boxplot+hist = time series + boxplot + histogram

pfreq
Character indicating how many plots are desired by the user. Valid values are:
- dma: Daily, Monthly and Annual values are plotted
- dm: Daily and Monthly values are plotted
- ma: Monthly and Annual values are plotted
- o: Only the original zoo object is plotted, and ptype is changed to ts
- seasonal: Line and boxplots of seasonal time series (see stype and season.names).
  When pfreq is seasonal, ptype is set to ts+boxplot

var.type
ONLY required when FUN is missing. character representing the type of variable being plotted. Used for determining the function used for computing the monthly and annual values when FUN is missing. Valid values are:
- Precipitation = FUN=sum
- Temperature = FUN=mean
- Flow = FUN=mean

var.unit
Character representing the measurement unit of the variable being plotted. ONLY used for labelling the axes (e.g., "mm" for precipitation, "C" for temperature, and "m3/s" for flow.)

main
Character representing the main title of the plot. If the user do not provide a title, this is created automatically as: main= paste(var.type, "at", sname, sep=" "),
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>xlab</code></td>
<td>A title for the x axis. See <code>plot</code>.</td>
</tr>
<tr>
<td><code>ylab</code></td>
<td>A title for the y axis. See <code>plot</code>.</td>
</tr>
<tr>
<td><code>win.len1</code></td>
<td>Number of days for being used in the computation of the first moving average. A value equal to zero indicates that this moving average is not going to be computed.</td>
</tr>
<tr>
<td><code>win.len2</code></td>
<td>Number of days for being used in the computation of the second moving average. A value equal to zero indicates that this moving average is not going to be computed.</td>
</tr>
<tr>
<td><code>tick.tstep</code></td>
<td>Character indicating the time step that have to be used for putting the ticks on the time axis. Valid values are: <code>)- days</code>, <code>)- months</code>, <code>)- years</code>.</td>
</tr>
<tr>
<td><code>lab.tstep</code></td>
<td>Character indicating the time step that have to be used for putting the labels on the time axis. Valid values are: <code>)- days</code>, <code>)- months</code>, <code>)- years</code>.</td>
</tr>
<tr>
<td><code>lab.fmt</code></td>
<td>Character indicating with the format to be used for the label of the axis. See format in <code>as.Date</code>. If not specified, it will try <code>&quot;%Y-%m-%d&quot;</code> when <code>lab.tstep=&quot;days&quot;</code>, <code>&quot;%b&quot;</code> when <code>lab.tstep=&quot;month&quot;</code>, and <code>&quot;%Y&quot;</code> when <code>lab.tstep=&quot;year&quot;</code>.</td>
</tr>
<tr>
<td><code>cex</code></td>
<td>A numerical value giving the amount by which plotting text and symbols should be magnified relative to the default. (See <code>par</code>).</td>
</tr>
<tr>
<td><code>cex.main</code></td>
<td>The magnification to be used for main titles relative to the current setting of cex. (See <code>par</code>).</td>
</tr>
<tr>
<td><code>cex.lab</code></td>
<td>The magnification to be used for x and y labels relative to the current setting of cex. (See <code>par</code>).</td>
</tr>
<tr>
<td><code>cex.axis</code></td>
<td>The magnification to be used for axis annotation relative to the current setting of cex. (See <code>par</code>).</td>
</tr>
<tr>
<td><code>col</code></td>
<td>A character vector with 3 elements, representing the colors to be used for plotting the lines of the ts, the boxplots, and the histograms, respectively. When <code>pfreq=&quot;o&quot;</code>, only one character element is needed. See <code>plot.default</code>).</td>
</tr>
<tr>
<td><code>dates</code></td>
<td>ONLY required when <code>x</code> is a data frame. It is a numeric, factor or Date object indicating how to obtain the dates corresponding to the sname station. If <code>dates</code> is a number (default), it indicates the index of the column in <code>x</code> that stores the dates. If <code>dates</code> is a factor, it is converted into Date class, using the date format specified by <code>date.fmt</code>. If <code>dates</code> is already of Date class, the code verifies that the number of days in <code>dates</code> be equal to the number of element in <code>x</code>.</td>
</tr>
<tr>
<td><code>date.fmt</code></td>
<td>Character indicating the format in which the dates are stored in <code>dates</code>, from and to. See format in <code>as.Date</code>. ONLY required when <code>class(dates)==&quot;factor&quot;</code> or <code>class(dates)==&quot;numeric&quot;</code>.</td>
</tr>
</tbody>
</table>
from  OPTIONAL, used for extracting a subset of values. Character indicating the starting date for the values to be extracted. It must be provided in the format specified by date.fmt.

to  OPTIONAL, used for extracting a subset of values. Character indicating the ending date for the values to be extracted. It must be provided in the format specified by date.fmt.

stype  OPTIONAL, only used when pfreq=seasonal. character, indicating which weather seasons will be used for computing the output. Possible values are:

  -) default => "winter"= DJF = Dec, Jan, Feb; "spring"= MAM = Mar, Apr, May; "summer"= JJA = Jun, Jul, Aug; "autumn"= SON = Sep, Oct, Nov
  -) FrenchPolynesia => "winter"= DJFM = Dec, Jan, Feb, Mar; "spring" = AM = Apr, May; "summer" = JJAS = Jun, Jul, Aug, Sep; "autumn" = ON = Oct, Nov

season.names  OPTIONAL, only used when pfreq=seasonal. character of length 4 indicating the names of each one of the weather seasons defined by stype. These names are only used for plotting purposes

h  OPTIONAL, only used when pfreq=seasonal, for plotting horizontal lines in each seasonal plot. numeric, with 1 or 4 elements, with the value used for plotting an horizontal line in each seasonal plot, in the following order: winter (DJF), spring (MAM), summer (JJA), autumn (SON).

... further arguments passed to the plot.zoo and axis functions or from other methods.

Details

Plots of the daily/monthly/annual/seasonal values of the time series given as input. Depending on the value of pfreq, daily, monthly, annual and/or seasonal time series plots, boxplots and histograms are produced. Depending on the value of ptype, time series plots, boxplots and/or histograms are produced.

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

See Also

sname2ts

Examples

#################
## Loading daily streamflows at the station Oca en Ona (Ebro River basin, Spain) ##
data(OcaEnOnaQts)

## 3 ts, 3 boxplots and 3 histograms
hydroplot(OcaEnOnaQts, FUN=mean, ylab= "Q", var.unit = "m3/s")

## only the original time series
hypsometric(0caEn0naQts, pfreq="o")

## only the year 1962 of the original time series
hypsometric(0caEn0naQts, pfreq="o", from="1962-01-01", to="1962-12-31")

## seasonal plots
hypsometric(0caEn0naQts, pfreq="seasonal", FUN=mean, stype="default")

## custom season names (let's assume to be in the Southern Hemisphere)
seasonal plots
hypsometric(0caEn0naQts, pfreq="seasonal", FUN=mean,
          stype="default", season.names=c("Summer", "Autumn", "Winter", "Spring"))

# Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPPTsMonthly)

# Plotting the monthly and annual values of precipitation at station "P0001",
# stored in 'EbroPPTsMonthly'.
sname2plot(EbroPPTsMonthly, sname="P0001", var.type="Precipitation", dates=1, pfreq="ma")

# Plotting seasonal precipitation at station "P0001"
sname2plot(EbroPPTsMonthly, sname="P0001", FUN=sum, dates=1, pfreq="seasonal",
          stype="default")

hypsometric

**Hypsometric Curve**

**Description**
Computes and plots the hypsometric curve corresponding to the data provided by a digital elevation model (DEM)

**Usage**

hypsometric(x, band=1, main="Hypsometric Curve",
            xlab="Relative Area above Elevation, (a/A)",
            ylab="Relative Elevation, (h/H)", col="blue", ...

**Arguments**

- **x** *SpatialGridDataFrame-class* object with the elevations of the catchment. Possibly, a raster file already read with the readGDAL function of the rgdal package.
- **band** integer or character indicating the band in x that stores the elevation data.
- **main** See plot. An overall title for the plot: see title.
- **xlab** See plot. A title for the x axis: see title.
- **ylab** See plot. A title for the y axis: see title.
- **col** See plot.default. The colors for lines and points.
- **...** further arguments passed to or from other methods
Details

The hypsometric curve and the hypsometric integral are non-dimensional measures of the proportion of the catchment above a given elevation.

Strahler (1952, 1964) further asserted that different types of landform have different characteristic shape of their hypsometric curves, dividing landforms into ‘young’ and ‘mature’ with decreasing hypsometric integral -the area under the hypsometric curve- with age.

Note

Based on http://osgeo.org.1803224.n2.nabble.com/hypsometric-integral-from-ecdf-curve-td2231345.html

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>, with contribution of Jan Schwanbeck.

References


Willgoose, G. and Hancock, G. 1998. Revisiting the hypsometric curve as an indicator of form and process in transport-limited catchment, Earth Surface Processes and Landforms 23, pp. 611-623

Examples

```r
## Not run:
# Loading the DEM
require(rgdal)
data(EbroDEM1000m)
dem <- EbroDEM1000m

# Plotting the DEM
require(sp)
spplot(dem, scales=list(draw=TRUE, y=list(rot=90)))

# Computing and plotting the hypsometric curve
hypsometric(dem)

# If the raster file has more than 1 band, and the elevation data are in a
# band different from 1:
dem$ELEVATION <- EbroDEM1000m$band1 # dummy example```

hypsometric
Description

Infill all the missing values (NA) in \( x \) with the corresponding values in \( \text{sim} \).

Usage

\[
\text{infillxy}(x, \ldots) \\
\text{## Default S3 method:} \\
\text{infillxy}(x, \text{sim}, \ldots) \\
\text{## S3 method for class 'matrix'} \\
\text{infillxy}(x, \text{sim}, \ldots) \\
\text{## S3 method for class 'data.frame'} \\
\text{infillxy}(x, \text{sim}, \ldots)
\]

Arguments

\( x \) numeric, data.frame or matrix in which some values are missing (NA).

\( \text{sim} \) numeric, data.frame or matrix, with the same dimension of \( x \), which contains the values that will be used for infilling the missing (NA) values in \( x \).

\( \ldots \) further arguments passed to or from other methods.

Details

It gives as a result an object of the same dimension of \( x \), in which all the NA values were infilled with the corresponding values of \( \text{sim} \).

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

Examples

\[
\text{obs} \leftarrow \text{c(1, NA, 3, 4, NA, 5)} \\
\text{sim} \leftarrow \text{rep(2, 6)} \\
\]

\[
\text{## Filling in the missing values in 'x' with the corresponding values in 'sim'} \\
\text{infillxy}(x=\text{obs, sim})
\]
**istdx**

**Inverse Standarization**

**Description**
This function back transforms a standarized vector/matrix \( z \) into their original values, i.e., re-scales all the values in the [0,1] interval to the original range of values \( z = \text{re-scale}(x) = x \times [ \text{xmax} - \text{xmin} ] + \text{xmin} \).

**Usage**

\[
\text{istdx}(x, \ldots)
\]

## Default S3 method:

\[
\text{istdx}(x, \text{xmin}, \text{xrange}, \ldots)
\]

**Arguments**

- **x**: standarized vector or matrix to be re-scaled, all the values have to be in the range [0,1]
- **xmin**: numeric with the minimum value(s) in the original \( x \)
  - if \( x \) is a vector, \text{xmin} has to be a real
  - if \( x \) is a matrix/data.frame, \text{xmin} has to be a vector, with the minimum values for each column of the original \( x \). In this case, the vector of minimums can be obtained as: \text{xmin} <- apply(\( x \), 2, min, na.rm=TRUE)
- **xrange**: numeric with the range of value(s) in the original \( x \)
  - if \( x \) is a vector, \text{xrange} has to be a real
  - if \( x \) is a matrix/data.frame, \text{xrange} has to be a vector, with the range of values for each column of the original \( x \). In this case, the vector of ranges can be obtained as:
    \[
    \text{xrange} <- \text{apply}(x, 2, \text{range}, \text{na.rm}=\text{TRUE})
    \]
    \[
    \text{xrange} <- \text{apply}(\text{xrange}, 2, \text{diff}, \text{na.rm}=\text{TRUE})
    \]
- **...**: further arguments passed to or from other methods

**Author(s)**

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

**See Also**

`stdx, scale`

**Examples**

## Loading daily streamflows at the station Oca en Ona (Ebro River basin, Spain)

```r
data(OcaEnOnaQts)
x <- OcaEnOnaQts
```

## Computing xmin and the range of 'x'

```r
data(OcaEnOnaQts)
x <- OcaEnOnaQts
```
izoo2rzoo

Irregular Zoo -> Regular Zoo

Description

It takes an irregular zoo object (with non-existing values for some dates) and converts it into a regularly spaced zoo object within the time period defined by from and to, by filling the missing dates with ‘NA’

Usage

izoo2rzoo(x, ...)

## Default S3 method:
izoo2rzoo(x, from= start(x), to= end(x), date.fmt= "%Y-%m-%d", tstep= "days", ...)

## S3 method for class 'zoo'

```r
xmin <- min(x, na.rm=TRUE)
r <- diff(range(x, na.rm=TRUE))

## Standarized variable
s <- stdx(x)

## Inverse of the standarized variable
si <- istdx(s, xmin, xrange=r)

## 'si' and 'x' should be the same
summary(x-si)

###########
### Standarizing a subset of the stations 9 to 12 in 'EbroPPtsMonthly'

## Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPPtsMonthly)

pp <- EbroPPtsMonthly[1:70,10:13]
xmin <- apply(pp, 2, min, na.rm=TRUE)
xrange <- apply(pp, 2, range, na.rm=TRUE)
xrange <- apply(xrange, 2, diff, na.rm=TRUE)

## Standarized variable
s <- stdx(as.matrix(pp))

## Inverse of the standarized variable
si <- istdx(s, xmin, xrange)

## 'si' and 'pp' should be the same
summary(pp - si)
```
izo2rzoo(x, from = start(x), to = end(x), date.fmt = "%Y-%m-%d", tstep = "days", ...)

Arguments

x irregular zoo object (vector or matrix) representing a time series (very likely read with some user-defined procedure, and with some missing values for particular days/months/years)
from Character indicating the starting date for creating the regularly spaced zoo object. The default value corresponds to the date of the first element of x. It has to be in the format indicated by date.fmt.
to Character indicating the ending date for creating the regularly spaced zoo object. The default value corresponds to the date of the last element of x. It has to be in the format indicated by date.fmt.
date.fmt character indicating the format in which the dates are stored in from and to, e.g. %Y-%m-%d. See ‘Details’ section in strptime.
tstep character, indicating the time step used for creating the time sequence going from from to to that will be used as time(x). Valid values are (but not limited to) days, months, years, hours
... further arguments passed to or from other methods

Details

If the full time period of x is a subset of the time period defined by from and to, the time period of the resulting zoo is the one defined by from and to, assigning ‘NA’ to all the dates in which x do not have a value.

Value

a regularly spaced zoo object, with values given by x and time stamps going from from to to at intervals defined by tsteps

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

See Also

vector2zoo

Examples

##
## Example 1: Adding NA for February 29th to an existing zoo object

dummy values and dates (February 29th is not present !)
x <- 1:9
"1964-03-02", "1964-03-03", "1964-03-04", "1964-03-05")
KarameaAtGorgeQts

Karamea at Gorge, time series of hourly streamflows

Description

Time series with hourly streamflows for the Karamea River (New Zealand) measured at the gauging station "Gorge", for the period 01/Jan/1980 to 31/Dec/1985. Station Number: 95102, Easting Coordinate (NZMG): 2444629.0, Northing Coordinate (NZMG): 5994427.0, Catchment Area (km2): 1160.0.
Usage

    data(KarameaAtGorgeQts)

Format

    zoo object.

Source

    Provided by the National Institute of Water and Atmospheric Research http://www.niwa.co.nz/,
    thanks to the gentle collaboration of Shailesh Singh

    These data are intended to be used for research purposes only, being distributed in the hope that it
    will be useful, but WITHOUT ANY WARRANTY.

---

ma  Moving Average

Description

    Generic function for computing a moving (sliding) average of ts.

Usage

    ma(x, ...)

    ## Default S3 method:
    ma(x, win.len, FUN = mean, ...)

    ## S3 method for class 'zoo'
    ma(x, win.len, FUN = mean, ...)

Arguments

    x                 ts or zoo object.
    win.len           number of terms that will be considered in the mean. It have to be odd
    FUN               Function that have to be applied for computing the moving average. Usually, FUN MUST be mean
    ...               further arguments passed to or from other methods.

Value

    a vector with the moving average terms. The length of the resulting vector is the same of x, but
    the first and last \((\text{win.len}-1)/2\) elements will be NA.
Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

Examples

```r
## Loading daily streamflows at the station Oca en Ona (Ebro River basin, Spain) ##
data(OcaEnOnaQts)
x <- OcaEnOnaQts

## Daily to Monthly ts
m <- daily2monthly(x, FUN=mean, na.rm=FALSE)

# Plotting the monthly values
plot(m, xlab="Time")

## Plotting the annual moving average in station 'x'
lines(ma(m, win.len=12), col="blue")
```

matrixplot

Matrixplot

Description

Plots a color matrix, representing the values stored in `x`. Originally, it was thought to represent the amount of days with information per year in a set of gauging stations, but it can be used for plotting the information stored in any two dimensional matrix.

Usage

```r
matrixplot(x, ColorRamp="Days", ncolors = 70, main = "", ...)
```

Arguments

- **x**: matrix to be plotted. Originally:
  - Each column of `x` represent a different gauging station, and it stores the values measured on it
  - Each row of `x` represent the years, and they stores the amount of days with information in each station
- **ColorRamp**: Character or function defining a personalized color ramp for plotting the maps. Valid character values are in `c("Days", "Precipitation", "Temperature", "PCPAnomaly", "PCPAnomaly2" "TEMPAnomaly", "TEMPAnomaly2", "TEMPAnomaly3").`
- **ncolors**: numeric, indicating the number of color intervals that will be used for representing the information content of `x`
- **main**: Main title for the plot
- **...**: further arguments passed to `levelplot` function (lattice package) or from other methods
Note

Adapted from: http://www2.warwick.ac.uk/fac/sci/moac/currentstudents/peter_cock/r/matrix_contour/

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

See Also
dwi

Examples

```r
## Loading the SanMartino precipitation data
data(SanMartinoPPTS)

# Selecting only the values up to Dec/1960
x <- window(SanMartinoPPTS, end=as.Date("1960-12-31"))

## Daily zoo to monthly zoo
m <- daily2monthly(x, FUN=sum, na.rm=TRUE)

# Creating a data.frame with monthly values per year in each column
M <- matrix(m, ncol=12, byrow=TRUE)
colnames(M) <- month.abb
rownames(M) <- unique(format(time(m), "%Y"))

# Plotting the monthly precipitation values from 1921 to 1960.
# Useful for identifying dry/wet months
matrixplot(M, ColorRamp="Precipitation",
           main="Monthly precipitation at San Martino st., [mm/month]"
)
```

---

### mip

**Months in Period**

**Description**

Given any starting and ending dates, it generates:
1) a vector of class 'Date' with all the months between the two dates (both of them included), OR
2) the amount of months between the two dates

**Usage**

```r
mip(from, to, date.fmt = "%Y-%m-%d", out.type = "seq")
```
Arguments

from  Character indicating the starting date for creating the sequence. It has to be in the format indicated by date.fmt.
to    Character indicating the ending date for creating the sequence. It has to be in the format indicated by date.fmt.
date.fmt  Character indicating the format in which the dates are stored in from and to, e.g. %Y-%m-%d. See format in as.Date.
out.type  character indicating the type of result that is given by this function. Valid values are:
  - seq : a vectorial sequence with all the months within the given year
  - nmbr: the number of days in the vectorial sequence with all the months within the given year

Value

Depending on the value of out.type, it returns:
1) a vector of class Date with all the months between from and to (both of them included), OR
2) a single numeric value with the amount of months between the two dates.

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

See Also
dip, diy, hip, yip

Examples

# Sequence of monthly dates between "1961-01-01" and "1961-12-31"
mip("1961-01-01", "1961-12-31")

## Computing the number of months between "1961-01-01" and "1965-06-30",
## with the date format "%d-%m-%Y"
mip("01-01-1961", "30-06-1965", date.fmt= "%d-%m-%Y", out.type = "nmbr")

Description

Generic function for obtaining 12 monthly values of a zoo object, by applying any R function to ALL the values in the object belonging to each one of the 12 calendar months (Jan...Dec).
Usage

monthlyfunction(x, ...)

## Default S3 method:
monthlyfunction(x, FUN, na.rm = TRUE, ...)

## S3 method for class 'zoo'
monthlyfunction(x, FUN, na.rm = TRUE, ...)

## S3 method for class 'data.frame'
monthlyfunction(x, FUN, na.rm = TRUE, dates = 1,
    date.fmt = "%Y-%m-%d", out.type = "data.frame", verbose = TRUE, ...)

## S3 method for class 'matrix'
monthlyfunction(x, FUN, na.rm = TRUE, dates = 1,
    date.fmt = "%Y-%m-%d", out.type = "data.frame", verbose = TRUE, ...)

Arguments

x 
   zoo, xts, data.frame or matrix object, with daily or monthly time series.
   Measurements at several gauging stations can be stored in a data.frame of matrix
   object, and in that case, each column of x represent the time series measured in
   each gauging station, and the column names of x have to correspond to the ID
   of each station (starting by a letter).

FUN 
   Function that will be applied to ALL the values in x belonging to each one of
   the 12 months of the year (e.g., FUN can be some of mean, sum, max, min, sd).

na.rm 
   Logical. Should missing values be removed?
   -) TRUE: the monthly values and FUN are computed considering only those
   values in x different from NA
   -) FALSE: if there is AT LEAST one NA within a month, the corresponding
   monthly value will be NA

dates 
   It is only used when x is not a zoo object.
   numeric, factor, Date indicating how to obtain the dates.
   If dates is a number (default), it indicates the index of the column in x that
   stores the dates
   If dates is a factor, it is converted into 'Date' class, using the date format speci-
   fied by date.fmt
   If dates is already of Date class, the code verifies that the number of days in
dates be equal to the number of elements in x

date.fmt 
   It is only used when x is not a zoo object.
   character indicating the format in which the dates are stored in dates, e.g. %Y-%m-%d.
   See format in as.Date.
   ONLY required when class(dates)=="factor" or class(dates)=="numeric".

out.type 
   It is only used when x is a matrix or data.frame.
   Character defining the desired type of output. Valid values are:
   -) data.frame: a data.frame, with 12 columns representing the months, and as
   many rows as gauging stations are included in x
monthlyfunction

- db : a data.frame, with 4 columns will be produced. Useful for a posterior boxplot
  The first column ('StationID') will store the ID of the station,
  The second column ('Year') will store the year,
  The third column ('Month') will store month,
  The fourth column ('Value') will contain the monthly value corresponding to
  the three previous columns.

verbose Logical; if TRUE, progress messages are printed
... further arguments passed to or from other methods

Value

When x is a zoo object, a numeric vector with 12 elements representing the computed monthly
value for each month.
When x is a data.frame which columns represent measurements at different gauging stations, the
resulting object is a data.frame with 12 columns and as many rows as gauging stations are in x, each
row storing the computed 12 monthly value for each gauging station.

Note

Due to the fact that FUN is applied over all the elements in x belonging to a given calendar month, its
result will depend on the sampling frequency of x and the type of function provided by FUN (special
attention have to be put when FUN=sum)

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

See Also

annualfunction, seasonalfunction, dm2seasonal, daily2monthly, daily2annual

Examples

```r
## Loading daily streamflows (3 years) at the station
## Oca en Ona (Ebro River basin, Spain)
data(OcaEnOnaQts)
x <- OcaEnOnaQts

## Mean monthly streamflows at station 'x'
monthlyfunction(x, FUN=mean, na.rm=TRUE)

#########################################################################
## Boxplot of monthly values

## Daily to Monthly
m <- daily2monthly(x, FUN=mean, na.rm=TRUE)

## Median of the monthly values at the station
```
monthlyfunction(m, FUN=median, na.rm=TRUE)

## Vector with the three-letter abbreviations of the month names
cmonth <- format(time(m), "%b")

## Creating ordered monthly factors
months <- factor(cmonth, levels=unique(cmonth), ordered=TRUE)

## Boxplot of the monthly values
boxplot( coredata(m) ~ months, col="lightblue", main="Monthly streamflows, [m3/s]"

#########################################################################
#########################################################################
# Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPPtsMonthly)
x <- EbroPPtsMonthly

## Dates of 'x'
dates <- as.Date(x[,1])

## Monthly precipitation of all the stations in 'x'
## Not run:

## Sum of the monthly values in each station of 'x'
z <- zoo( x[, 2:ncol(x)], dates)

# Amount of years in 'x' (needed for computing the average)
years <- yip(from=start(z), to=end(z), out.type="nmb")

m <- monthlyfunction(z, FUN=sum)

## Another way of computing the sum of the monthly values in each station of 'x'
## This way is usefult for posteriori boxplots
m2 <- monthlyfunction(x, FUN=sum, dates=1, out.type="db")

## Average monthly precipitation in each station of 'x'
m2$Value <- m2$Value / years

## Creating monthly factors
m2$Month <- factor(m2$Month, levels=month.abb)

## boxplot of the monthly values in all stations
boxplot(Value ~ Month, m2, col="lightyellow", main="Monthly Precipitation, [mm/month]"

## End(Not run)
Description

Plots several spatial maps in the same plotting window, with options to easily add a scale bar and north arrow.
Originally, it was thought to make easier the display of several maps (of the same spatial extent) obtained by different interpolation methods or for different time steps.

Usage

mspplot(x, subcatchments, IDvar = NULL, p4s=CRS(as.character(NA)),
plot = TRUE, ColorRamp="PCPAnomaly",col.nintv = 10, col.at = "auto",
main, stations.plot = FALSE, stations.gis, X, Y,
arrow.plot = FALSE, arrow.offset, arrow.scale,
scalebar.plot = FALSE, sb.offset, sb.scale, verbose = TRUE)

Arguments

x        SpatialPixelsDataFrame-class object that stores (in the @data slot) all the maps that will be plotted.
subcatchments  SpatialPolygonsDataFrame-class with all the subcatchments within the study area, OR character representing the filename (with path) of the shapefile (’polygon’ type) that stores those subcatchments.
IDvar   See readShapePoly. Character string with the name of a column in the subcatchments shapefile DBF containing the ID values of the catchments - the values will be converted to a character vector.
p4s    Character with information about the projection of the GIS files, usually created by the CRS function of the sp package
plot    Logical, indicating if the interpolated values have to be plotted or not
ColorRamp    Character or function defining a personalized color ramp for plotting the maps. Valid character values are in c("Precipitation", "Temperature", "PCPAnomaly", "PCPAnomaly2", "TEMPAnomaly", "TEMPAnomaly2", "TEMPAnomaly3").
col.nintv    integer, number of colors that have to be used for plotting the interpolated values
col.at     Specify at which interpolated values colours change. Valid values are:
            R: uses the default setting of ‘spplot’
            auto: default option.
at <- seq(min, max,length.out=col.nintv)
min <- floor( min(idw["var1.pred"]@data, na.rm=TRUE))
max <- ceiling( max(idw["var1.pred"]@data, na.rm=TRUE))
            numeric: vector giving the exact values in which the colors have to change.
            Useful when the user desires the same color for the same value when comparing two or more maps with different range of values
main    Character with the title to be used for the plot
stations.plot    Logical, indicating if the gauging stations, defined by stations.gis have to be plotted
stations.gis    OPTIONAL. data.frame with the stations that will be added to the plot. ONLY required when stations.plot == TRUE.
**X**  
OPTIONAL. character, field name in `x.gis` that stores the easting coordinate of the stations. ONLY required when `stations.plot` == TRUE.

**Y**  
OPTIONAL. character, field name in `x.gis` that stores the northing coordinate of the stations. ONLY required when `stations.plot` == TRUE.

**arrow.plot**  
Logical, indicating if a North Arrow have to be plotted

**arrow.offset**  
OPTIONAL. 2D list with the numeric coordinates in which the North Arrow have to be plotted. e.g., `arrow.offset = c(690000,4760000)`. ONLY required when `arrow.plot`=TRUE

**arrow.scale**  
OPTIONAL. Scale (in the map units) to be used for plotting the North Arrow, e.g., `scale = 20000`. ONLY required when `arrow.plot`=TRUE.

**scalebar.plot**  
Logical, indicating if a Scale Bar have to be plotted

**sb.offset**  
OPTIONAL. 2D list with the numeric coordinates in which the North Arrow have to be plotted. e.g., `sb.offset = c(400000,4490000)`. ONLY required when `scalebar.plot`=TRUE

**sb.scale**  
OPTIONAL. Scale (in the map units) to be used for plotting the Scale Bar, e.g., `scale = 100000`, means that the scale bar will have a length of 100km. ONLY required when `scalebar.plot`=TRUE.

**verbose**  
logical; if TRUE, progress messages are printed

**Author(s)**

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

**References**


http://r-spatial.sourceforge.net/gallery/

**See Also**

`spplot`, `krige`, `autoKrige`

**Examples**

```r
## Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPptsMonthly)

## Loading the gis data
data(EbroPPgis)

## Loading the shapefile with the subcatchments
data(EbroCatchmentsCHE)

## Projection for the Subcatchments file
require(sp)
p4s <- CRS("+proj=utm +zone=30 +ellps=intl +units=m +no_defs")
```
## Field name in 'x.gis' with the ID of the station
sname <- "ID"

## Field name in 'x.gis' with the name of the catchment to which each station belongs
bname <- "CHE_BASIN_NAME"

## Field name in 'x.gis' with the Easting spatial coordinate
X <- "EAST_ED50"

## Field name in 'x.gis' with the Northing spatial coordinate
Y <- "NORTH_ED50"

## Field name in 'x.gis' with the Elevation
elevation <- "ELEVATION"

### Selecting Jan/1961 (first row) of 'EbroPPtsMonthly' in all the stations
x.ts <- as.numeric(EbroPPtsMonthly[1, 2:ncol(EbroPPtsMonthly)])

### Setting the name of the stations
names(x.ts) <- colnames(EbroPPtsMonthly[, 2:ncol(EbroPPtsMonthly)])

### IDW interpolation and plot (Jan/61)
x.idw <- hydrokrige(x.ts = x.ts, x.gis=EbroPgis,
X=X, Y=Y, sname=sname, bname=bname, elevation=elevation,
type = "cells", #'both'
subcatchments= EbroCatchmentsCHE, p4s = p4s,
cell.size= 3000, nmax= 50,
ColorRamp = "Precipitation",
main = "IDW Mean Annual Precipitation on the Ebro, Jan/1961")

### Storing the interpolated values
x.idw@data["Jan1961"] <- x.idw@data["var1.pred"]
x.idw@data["var1.pred"] <- NULL
x.idw@data["var1.var"] <- NULL

### Selecting the Jul/1961 of 'EbroPPtsMonthly' for all the stations
x.ts <- as.numeric(EbroPPtsMonthly[7, 2:ncol(EbroPPtsMonthly)])

### Setting the name of the stations
names(x.ts) <- colnames(EbroPPtsMonthly[, 2:ncol(EbroPPtsMonthly)])

### Not run:
### IDW interpolation and plot (Jul/61)
x.idw2 <- hydrokrige(x.ts = x.ts, x.gis=EbroPgis,
X=X, Y=Y, sname=sname, bname=bname, elevation=elevation,
type = "cells", #'both'
subcatchments= EbroCatchmentsCHE, p4s = p4s,
cell.size= 3000, nmax= 50,
ColorRamp = "Precipitation",
main = "IDW Mean Annual Precipitation on the Ebro, Jul/1961")
OcaEnOnaQts

# Adding the interpolated value for Jul/1961 to 'x.idw'
x.idw@data["Jul1961"] <- x.idw2@data["var1.pred"]

## Plotting in the same graph the 2 interpolated fields
msppplot(x=x.idw,
  subcatchments=EbroCatchmentsCHE,
  IDvar=NULL, p4s,
  col.nintv=50,
  main="IDW Monthly Precipitation on the Ebro River basin, [mm],",
  stations.plot=FALSE,
  arrow.plot=TRUE, arrow.offset=c(900000,4750000), arrow.scale=20000,
  scalebar.plot=TRUE, sb.offset=c(400000,4400000), sb.scale=100000)

## End(Not run)

---

OcaEnOnaQts  

Oca in "Ona" (Q0931), time series of daily streamflows.

Description

Time series with daily streamflows of the Oca River (subcatchment of the Ebro River basin, Spain) measured at the gauging station "Ona" (Q093), for the period 01/Jan/1961 to 31/Dic/1963.

Usage

data(OcaEnOnaQts)

Format

zoo object.

Source


These data are intended to be used for research purposes only, being distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY.
### rm1stchar

**Remove First Character(s)**

#### Description

Deletes the first \( n \) character(s) of a character object.

#### Usage

\[
\text{rm1stchar}(x, \ n = 1)
\]

#### Arguments

- \( x \)  
  Character, e.g., each element may represent the name of a single gauging station.

- \( n \)  
  numeric, indicating the number of characters that have to be removed from the beginning of \( x \)

#### Value

character object of the same length as \( x \).

#### Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

#### See Also

- \texttt{substr}

#### Examples

```r
## Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPPTSMonthly)

# Getting the name of each gauging station.
names <- colnames(EbroPPTSMonthly)

# Removing the initial letter 'P' of the name of each gauging station.
rm1stchar(names)
```
Description
Daily time series of precipitation, at station San Martino di Castrozza, Trento Province, Italy, with data from 01/Jan/1921 to 31/Dec/1990.

Usage
data(SanMartinoPPts)

Format
zoo object.

Source
Provided by MeteoTrentino, Trento, Italy (via prof. Riccardo Rigon). These data are intended to be used for research purposes only, being distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY.

seasonalfunction
Seasonal Function

Description
Generic function for applying any R function to a zoo object, in order to obtain 4 representative seasonal values.

Usage
seasonalfunction(x, ...)

## Default S3 method:
seasonalfunction(x, FUN, na.rm = TRUE, type="default", ...)

## S3 method for class 'zoo'
seasonalfunction(x, FUN, na.rm = TRUE, type="default", ...)

## S3 method for class 'data.frame'
seasonalfunction(x, FUN, na.rm = TRUE, type="default",
    dates=1, date.fmt = "%Y-%m-%d",
    out.type = "data.frame", verbose = TRUE, ...)

## S3 method for class 'matrix'
seasonalfunction(x, FUN, na.rm = TRUE, type="default",
      dates=1, date.fmt = "%Y-%m-%d",
      out.type = "data.frame", verbose = TRUE, ...)

Arguments

x zoo, data.frame or matrix object, with daily or monthly time series.
Measurements at several gauging stations can be stored in a data.frame or matrix
object, and in that case, each column of x represent the time series measured in
each gauging station, and the column names of x have to correspond to the ID
of each station (starting by a letter).

FUN Function that will be applied to ALL the values in x belonging to each one of
the 4 weather seasons (e.g., FUN can be some of mean, max, min, sd).

na.rm Logical. Should missing values be removed before the computations?
- TRUE : the monthly values are computed considering only those values in x
different from NA (very important when FUN=mean)
- FALSE: if there is AT LEAST one NA within a month, the FUN and monthly
  values are NA

type character, indicating which weather seasons will be used for computing the output.
Possible values are:
- default => "winter"= Dec, Jan, Feb; "spring"= Mar, Apr, May; "summer"=Jun,
  Jul, Aug; "autumn"= Sep, Oct, Nov
- FrenchPolynesia => "winter"= Dec, Jan, Feb, Mar; "spring"= Apr, May;
  "summer"=Jun, Jul, Aug, Sep; "autumn"= Oct, Nov

dates numeric, factor, Date indicating how to obtain the dates.
If dates is a number (default), it indicates the index of the column in x that
stores the dates
If dates is a factor, it is converted into Date class, by using the date format
specified by date.fmt
If dates is already of Date class, the code verifies that the number of days in
dates be equal to the number of element in x

date.fmt Character indicating the format in which the dates are stored in dates, e.g.
%Y-%m-%d. See format in as.Date.
ONLY required when class(dates)=="factor" or class(dates)=="numeric".

out.type Character defining the desired type of output. Valid values are:
- data.frame: a data.frame, with 4 columns representing the weather seasons,
  and as many rows as stations are included in x
- db : a data.frame, with 4 columns will be produced. Useful for a posterior
  boxplot
The first column (StationID) will store the ID of the station,
The second column (Year) will store the year,
The third column (Season) will store the season,
The fourth column (Value) will contain the seasonal value corresponding to that
year and that station.

verbose Logical; if TRUE, progress messages are printed

... further arguments passed to or from other methods
seasonalfunction

Warning

The FUN value for the winter season (DJF) is computed considering the consecutive months of December, January and February. Therefore, if x starts in January and ends in December of any year, the winter value of the first year is computed considering only the January and February value of that year, whereas the December value of the first year is used to compute the winter value of the next year.

Note

FUN is applied to all the values of x belonging to each one of the four weather seasons, so the results of this function depends on the frequency sampling of x and the type of function given by FUN.

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

See Also

dm2seasonal, time2season, monthlyfunction, annualfunction, extract

Examples

```r
## Loading the SanMartino precipitation data
data(SanMartinoPpts)
x <- SanMartinoPpts

# Amount of years
nyears <- yip(from=start(x), to=end(x), out.type="nmbr")

## Mean annual precipitation.
# It is necessary to divide by the amount of years to obtain the mean annual value,
# otherwise it will give the total precipitation for all the 70 years
seasonalfunction(x, FUN=sum, na.rm=TRUE) / nyears

############################
#### verification ####
# Mean winter (DJF) value
sum( extractzoo(x, trgt="DJF") ) / nyears

# Mean spring (MAM) value
sum( extractzoo(x, trgt="MAM") ) / nyears

# Mean summer (JJA) value
sum( extractzoo(x, trgt="JJA") ) / nyears

# Mean autumn (SON) value
sum( extractzoo(x, trgt="SON") ) / nyears
```
sfreq

Sampling Frequency

Description

This function identifies the sampling frequency of a zoo object. So far, it only works with daily/monthly/annual ts.

Usage

sfreq(x, min.year = 1800)

Arguments

x variable of type zoo, xts or ts, with AT LEAST 2 elements, AND with a daily, monthly or annual sampling frequency.

min.year integer used for a correct identification of the sampling frequency when x is an annual time series.

Value

Character. Possible values are:
- daily: indicating that the sampling frequency in x is daily
- monthly: indicating that the sampling frequency in x is monthly
- annual: indicating that the sampling frequency in x is annual

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

See Also

frequency

Examples

## Loading temperature data ##
## Loading daily streamflows at the station Oca en Ona (Ebro River basin, Spain) ##
data(OcaEnOnaQts)
d <- OcaEnOnaQts

## Daily to Monthly
m <- daily2monthly(d, FUN=mean, na.rm=TRUE)

## Daily to Annual
a <- daily2annual(d, FUN=mean, na.rm=TRUE)

# Daily zoo object
smry

sfreq(d)

# Monthly zoo object
sfreq(m)

# Annual zoo object
sfreq(a)

smry  Summary

Description

Extended summary function for numeric objects, with 13 summary statistics.

Usage

smry(x, ...)

## Default S3 method:
smry(x, na.rm=TRUE, digits = max(3, getOption("digits")-3), ...)

## S3 method for class 'zoo'
smry(x, na.rm=TRUE, digits = max(3, getOption("digits")-3), ...)

## S3 method for class 'Date'
smry(x, na.rm=TRUE, digits = max(3, getOption("digits")-3), ...)

## S3 method for class 'matrix'
smry(x, na.rm=TRUE, digits = max(3, getOption("digits")-3), ...)

## S3 method for class 'data.frame'
smry(x, na.rm=TRUE, digits = max(3, getOption("digits")-3), ...)

Arguments

x  a numeric object, vector, matrix or data.frame, for which a summary is desired.
na.rm  a logical value indicating whether 'NA' values should be stripped before the computation proceeds.
digits  numeric, with the amount of decimal places to be included in the result
...  further arguments passed to or from other methods.
Value

Computed summary statistics are:

- **Min**: Minimum
- **1stQ**: First quartile (lower-hinge)
- **Mean**: Mean value
- **Median**: Median
- **3rdQ**: Third quartile (upper-hinge)
- **Max**: Maximum of the input values.
- **IQR**: Interquartile Range. \( IQR(x) = \text{quantile}(x,3/4) - \text{quantile}(x,1/4) \)
- **sd**: Standard deviation. It uses 'n-1' as denominator.
- **cv**: Coefficient of variation \( (cv = \frac{sd}{|mean|}) \)
- **skewness**: Skewness (using e1071 package)
- **kurtosis**: Kurtosis (using e1071 package)
- **n**: Total number of elements
- **NA's**: Amount of missing values

Note

Skewness and Kurtosis are computed with the e1071 package

Author(s)

Mauricio Zambrano-Bigiarini <mzb.devel@gmail>

See Also

- summary
- fivenum
- IQR
- sd
- skewness
- kurtosis

Examples

```r
## Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPPtsMonthly)

## Summary of monthly precipitation values for the first 7 stations in 'EbroPPtsMonthly'
smry(EbroPPtsMonthly[,2:8])
```
Description
This function takes a `data.frame` whose columns contain the time series of several gauging stations, along with a character representing the name of one gauging station, and extracts the time series corresponding to that station.

Usage
```
sname2ts(x, sname, dates=1, date.fmt = "%Y-%m-%d", var.type,
    tstep.out = "daily", FUN, na.rm = TRUE, from, to)
```

Arguments
- `x`: `data.frame` containing the complete time series of all the stations. It may also contain 1 column with the dates of the measurements, or they can be provided in a different way (see `dates` below).
- `sname`: Character representing the name of a station, which have to correspond to one column name in `x`.
- `dates`: numeric, factor, Date object indicating how to obtain the dates corresponding to the `sname` station.
  - If `dates` is a number (default), it indicates the index of the column in `x` that stores the dates.
  - If `dates` is a factor, it is converted into Date class, using the date format specified by `date.fmt`.
  - If `dates` is already of Date class, the code verifies that the number of days in `dates` be equal to the number of element in `x`.
- `date.fmt`: character indicating the format in which the dates are stored in `dates`, e.g. `%Y-%m-%d`. See format in `as.Date`.
  ONLY required when `class(dates)="factor" or class(dates)="numeric"`
- `var.type`: character representing the type of variable being plotted. Used for determining the function used for computing the monthly or/and annual values when `FUN` is missing. Valid values are:
  - Precipitation => FUN=sum
  - Temperature => FUN= mean
  - Flow => FUN= mean
- `tstep.out`: character that defines the time step of the desired output time series. Valid values are:
  - daily: daily time series
  - monthly: monthly time series
  - annual: annual time series
- `FUN`: ONLY required when `var.type` is missing and `tstep` is one of monthly or annual.
Function that have to be applied for transforming from daily to monthly or annual time step (e.g., for precipitation FUN=sum and for temperature and flow ts, FUN=mean)

na.rm a logical value indicating whether 'NA' values should be stripped before the computation proceeds.

from OPTIONAL, used for extracting a subset of values.

Character indicating the starting date for the values to be extracted. It must be provided in the format specified by date.fmt.

to OPTIONAL, used for extracting a subset of values.

Character indicating the ending date for the values to be extracted. It must be provided in the format specified by date.fmt.

Value

zoo object

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

See Also

sname2plot

Examples

## Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPptsMonthly)

## Annual values of temperature at the station "T9105", stored in 'EbroPptsMonthly'.
sname2ts(EbroPptsMonthly, sname="P9001", dates=1, FUN=sum, tstep.out="annual")

---

stdx 

**Standarization**

Description

Standarizes a vector or matrix, i.e., scales all the values in a way that the transformed values will be within the range [0, 1].

Usage

stdx(x, ...)

Arguments

- x vector, matrix or data.frame to be scaled
- ... further arguments passed to or from other methods
Details

\[ z = \frac{x - x_{\min}}{x_{\max} - x_{\min}} \]

Author(s)

Mauricio Zambrano-Bigiarini, &lt;mzb.devel@gmail&gt;

See Also

scale, istdx

Examples

#######
## Loading the monthly time series of precipitation within the Ebro River basin.
data(EbroPPtsMonthly)

# Standarizing only some values of 'EbroPPtsMonthly'
stdx(as.matrix(EbroPPtsMonthly[1:70,10:13]))

---

### subdaily2daily

Sub-daily -> Daily

Description

Generic function for transforming a Sub-DAILY time series into a DAILY one

Usage

subdaily2daily(x, ...)

## Default S3 method:
subdaily2daily(x, FUN, na.rm = TRUE, ...)

## S3 method for class 'zoo'
subdaily2daily(x, FUN, na.rm = TRUE, ...)

## S3 method for class 'data.frame'
subdaily2daily(x, FUN, na.rm = TRUE, dates=1, date.fmt="%Y-%m-%d %H:%M:%S", out.fmt="zoo", verbose= TRUE, ...)

## S3 method for class 'matrix'
subdaily2daily(x, FUN, na.rm = TRUE, dates=1, date.fmt="%Y-%m-%d %H:%M:%S", out.fmt="zoo", verbose= TRUE, ...)
Arguments

x  xts, data.frame or matrix object, with sub-daily time series. Measurements at several gauging stations can be stored in a data.frame or matrix object, and in that case, each column of x represent the time series measured in each gauging station, and the column names of x should correspond to the ID of each station (starting by a letter).

FUN  Function that have to be applied for transforming from sub-daily to daily time step. (e.g., for precipitation FUN=sum and for temperature and streamflow ts, FUN=mean).

na.rm  Logical. Should missing values be removed?
   - TRUE: the daily values are computed considering only those values different from NA
   - FALSE: if there is AT LEAST one NA sub-daily value within a day, the corresponding daily value(s) will be NA as well

dates  numeric, factor, POSIXct or POSIXt object indicating how to obtain the dates and times for each gauging station
   If dates is a number, it indicates the index of the column in x that stores the date and times
   If dates is a factor, it is converted into POSIXct class, using the date format specified by date.fmt
   If dates is already of POSIXct or POSIXt class, the code verifies that the number of elements on it be equal to the number of elements in x

date.fmt  character indicating the format in which the dates are stored in dates. By default date.fmt=“%Y-%m-%d %H:%M:%S”. See format in as.Date.
   ONLY required when class(dates)==”factor” or class(dates)==”numeric”.

out.fmt  OPTIONAL. Only used when x is a matrix or data.frame object /cr character, for selecting if the result will be a matrix/data.frame or a zoo object. Valid values are: numeric, zoo (default)

verbose  logical; if TRUE, progress messages are printed

...  further arguments passed to or from other methods.

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>
time2season

# Plotting the hourly streamflow values
plot(x)

## sub-daily to Daily

d <- subdaily2daily(x, FUN=sum, na.rm=TRUE)

# Plotting the daily streamflow values
plot(d)

time2season       Date/DateTime character  ->  Seasonal character

Description

This function transforms a character vector of Dates or DateTimes into a character vector of seasons (summer, winter, autumn, spring), depending on the value of type:

When type=default  
  - winter = DJF: December, January, February
  - spring = MAM: March, April, May
  - summer = JJA: June, July, August
  - autumn = SON: September, October, November

When type=frenchpolynesia
  - winter = DJFM: December, January, February, March
  - spring = AM: April, May
  - summer = JJAS: June, July, August, September
  - autumn = ON: October, November

Usage

time2season(x, out.fmt = "months", type="default")

Arguments

x          vector with the dates that have to be transformed. class(x) must be Date
out.fmt    character, indicating the format of the output seasons. Possible values are:
            - seasons => c("winter", "spring", "summer", autumn")
            - months => c("DJF", "MAM", "JJA", SON") or c("DJFM", "AM", "JJAS", ON")
type       character, indicating which weather seasons will be used for computing the output. Possible values are:
            - default => "winter"= Dec, Jan, Feb; "spring"= Mar, Apr, May; "summer"=Jun, Jul, Aug; "autumn"= Sep, Oct, Nov
            - FrenchPolynesia => "winter"= Dec, Jan, Feb, Mar; "spring"= Apr, May; "summer"=Jun, Jul, Aug, Sep; "autumn"= Oct, Nov

Value

character vector with the weather season to which each date in x belongs
Note

Weather seasons corresponding to French Polynesia were defined following a comment from Lydie Sichoix

Author(s)

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

See Also

dm2seasonal, seasonalfunction, extract, dip, mip

Examples

```r
## Sequence of daily dates between "1961-01-01" and "1961-12-31"
t <- dip("1961-01-01", "1961-12-31")
time2season(t)

## Sequence of monthly dates between "1961-01-01" and "1961-12-31"
t <- mip("1961-01-01", "1961-12-31")
time2season(t)
time2season(t, out.fmt="seasons")
```

---

vector2zoo

### Description

Transform a numeric vector and its corresponding dates into a zoo object.

### Usage

```r
vector2zoo(x, dates, date.fmt = "%Y-%m-%d")
```

### Arguments

- **x**: numeric vector
- **dates**: character, factor, Date or POSIXct object with the dates corresponding to each element of x. Valid object class for dates are: character, factor, Date, POSIXct
- **date.fmt**: character indicating the format in which the dates are stored in dates, e.g. %Y-%m-%d. See ‘Details’ section in `strptime`. ONLY required when class(dates)=="factor" or class(dates)=="character".

### Value

a zoo object, with values given by x and time stamps given by dates
**Author(s)**

Mauricio Zambrano-Bigiarini, <mzb.devel@gmail>

**See Also**

zoo, izoo2rzo, dip, mip, yip

**Examples**

```r
## Example1: creating daily data

# Generating a numeric variable (e.g., read from the outputs of an hydrological model)
x <- 1:31

# Generating the dates corresponding to the previous values
dates <- dip("1961-01-01", "1961-01-31")

## Transforming from 'numeric' to 'zoo' class
z <- vector2zoo(x, dates)

## Example2: creating hourly data

# Generating a numeric variable
x <- rnorm(7)

# Generating hourly times since 17:00:00 up to 23:00:00 for 2012-Oct-15
dates <- ISOdatetime(2012, 10, 15, 17:23, 00, 0)

## Transforming from 'numeric' to 'zoo' class
z <- vector2zoo(x, dates)
```

---

**yip**

<table>
<thead>
<tr>
<th>Years in Period</th>
</tr>
</thead>
</table>

**Description**

Given any starting and ending dates, it generates:
1) a vector of class Date with all the years between the two dates (both of them included), OR
2) the amount of years between the two dates

**Usage**

```r
yip(from, to, date.fmt = "%Y-%m-%d", out.type = "seq")
```
Arguments

from Character indicating the starting date for creating the sequence. It has to be in the format indicated by date.fmt.

to Character indicating the ending date for creating the sequence. It has to be in the format indicated by date.fmt.

date.fmt character indicating the format in which the dates are stored in from and to, e.g. %Y-%m-%d. See format in \texttt{as.Date}.

out.type Character indicating the type of result that is given by this function. Valid values are:
- seq => a vectorial sequence with all the years within the given dates.
- nmbr => the number of years within the given dates.

Value

Depending on the value of \texttt{out.type}, it returns:
1) seq : a vector of class Date with all the years between from and to (both of them included), OR
2) nmbr : a single numeric value with the amount of years between the two dates.

Author(s)

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See Also

dip, diy, mip

Examples

\begin{verbatim}
# Sequence of monthly dates between "1961-01-01" and "1961-12-31"
yip("1961-01-01", "1961-12-31")

## Computing the number of years between 1961 and 1975,## by using "%d-%m-%Y" as date format. ## yip("01-01-1961", "01-01-1975", date.fmt= "%d-%m-%Y", out.type = "nmbr")
\end{verbatim}

---

\texttt{zoo2RHtest} \quad \textit{Zoo -> RHTest}

Description

It creates the input file to the 'RHtest_dlyPrcp.r' script, used for testing the homogeneity of climatological time series (available at: \url{http://etccdi.pacificclimate.org/software.shtml})

Usage

\texttt{zoo2RHtest(x, fname="pcp.txt", tstep.out="daily", dec=","., na="-999.0")}
Arguments

- **x**: time series that will be written. `class(x)` must be a zoo object.
- **fname**: Character, with the filename of the precipitation time series.
- **tstep.out**: Character indicating the time step that have to be used for writing `x` into the output file.
- **dec**: the string to use for decimal points in numeric or complex columns: must be a single character.
- **na**: character to be used for representing the missing values in the data.

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References

- [http://etccdi.pacificclimate.org/software.shtml](http://etccdi.pacificclimate.org/software.shtml)

Examples

```r
## Loading the SanMartino precipitation data
data(SanMartinoPPTs)
x <- SanMartinoPPTs

# Getting the monthly ts
pcp.m <- daily2monthly(x, FUN=sum, na.rm=FALSE)

# From zoo to the input format required by 'findU.dlyPrcp' function
zoo2RHtest(x=pcp.m, fname="pcp-monthly.txt", tstep.out="monthly", na="-999.0")

## Not run:
# Homogeneity analysis
findU.dlyPrcp(InSeries="pcp-monthly.txt", output="pcp-monthly", MissingValueCode="-999.0", GUI=FALSE, pthr=0, Mq=10, p.lev=0.95, Iadj=10000)

## End(Not run)
```
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