Package 'timeSeries'

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Title Financial Time Series Objects (Rmetrics)

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Description 'S4' classes and various tools for financial time series:
Basic functions such as scaling and sorting, subsetting,
mathematical operations and statistical functions.

Depends R (>= 2.10), graphics, grDevices, stats, methods, utils,
timeDate (>= 2150.95)

Suggests RUnit, robustbase, xts, PerformanceAnalytics, fTrading

LazyData yes

License GPL (>= 2)

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http://www.rmetrics.org

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R topics documented:

`timeSeries-package` *Utilities and Tools Package*

Description

Package of time series tools and utilities.

Details

Package:	timeSeries
Type:	Package
Version:	see description file
Date:	2011
License:	GPL Version 2 or later
Copyright:	(c) 1999-2014 Rmetrics Association
URL:	`http://www.rmetrics.org`

timeSeries - S4 timeSeries Class

`timeSeries`	Creates a 'timeSeries' from scratch
`getDataPart, series`	...
`getUnits`	Extracts the time serie units
`getTime, time`	Extracts the positions of timestamps
`use: slot`	Extracts the format of the timestamp
`getFinCenter, finCenter`	Extracts the financial center
`use: slot`	Extracts the record IDs
`getTitle`	Extracts the title
`use: slot`	Extracts the documentation

Base Time Series Functions

apply	Applies a function to blocks of a 'timeSeries'
attach	Attaches a 'timeSeries' to the search path
cbind	Combines columns of two 'timeSeries' objects
rbind	Combines rows of two 'timeSeries' objects
diff	Returns differences of a 'timeSeries' object
dim	returns dimensions of a 'timeSeries' object
merge	Merges two 'timeSeries' objects
rank	Returns sample ranks of a 'timeSeries' object
rev	Reverts a 'timeSeries' object
sample	Resamples a 'timeSeries' object
scale	Scales a 'timeSeries' object
sort	Sorts a 'timeSeries' object
start	Returns start date/time of a 'timeSeries'
end	Returns end date/time of a 'timeSeries'
t	Returns the transpose of a 'timeSeries' object

Subsetting 'timeSeries' Objects

.subset_	Subsets 'timeSeries' objects
.findIndex	Index search in a 'timeSeries' object
[	Subsets a 'timeSeries' object
[<-]	Assigns values to a subset
$	Subsets a 'timeSeries' by column names
$<-	Replaces Subset by column names
t	Returns the transpose of a 'timeSeries'
head	Returns the head of a 'timeSeries'
tail	Returns the tail of a time Series
na.omit	Handles NAs in a timeSeries object
removeNA	removes NAs from a matrix object
substituteNA	substitutes NAs by zero, column mean or median
interpNA	interpolates NAs using R's "approx" function

Mathematical Operation

Ops.timeSeries	S4: Arith method for a 'timeSeries' object
abs	Returns absolute values of a 'timeSeries' object
sqrt	Returns square root of a 'timeSeries' object
exp	Returns the exponential values of a 'timeSeries' object
log	Returns the logarithm of a 'timeSeries' object
sign	Returns the signs of a 'timeSeries' object
diff	Differences a 'timeSeries' object
scale	Centers and/or scales a 'timeSeries' object
quantile	Returns quantiles of an univariate 'timeSeries'

Methods

as.timeSeries	Defines method for a 'timeSeries'
as.*.default	Returns the input
as.*.ts	Transforma a 'ts' object into a 'timeSeries'
as.*.data.frame	Transforms a 'data.frame' intp a 'timeSeries
as.*.character	Loads and transforms from a demo file
as.*.zoo	Transforms a 'zoo' object into a 'timeSeries'
as.vector.*	Converts univariate timeSeries to vector
as.matrix.*	Converts timeSeries to matrix
as.numeric.*	Converts timeSeries to numeric
as.data.frame.*	Converts timeSeries to data.frame
as.ts.*	Converts timeSeries to ts
as.logical.*	Converts timeSeries to logical
is.timeSeries	Tests for a 'timeSeries' object
plot	Displays a X-Y 'timeSeries' Plot
lines	Adds connected line segments to a plot
points	Adds Points to a plot
show	Prints a 'timeSeries oobject

Financial time series functions

align	Aligns a 'timeSeries' to time stamps
cumulated	Computes cumulated series from a returns
alignDailySeries	Aligns a 'timeSeries' to calendarical dates
rollDailySeries	Rolls a 'timeSeries daily
drawdowns	Computes series of drawdowns from financial returns
drawdownsStats	Computes drawdowns statistics
durations	Computes durations from a financial time series
countMonthlyRecords	Counts monthly records in a 'timeSeries'
rollMonthlyWindows	Rolls Monthly windows
rollMonthlySeries	Rolls a 'timeSeries' monthly
endOfPeriodSeries	Returns end of periodical series
endOfPeriodStats	Returns end of period statistics
endOfPeriodBenchmarks	Returns period benchmarks
returns	Computes returns from prices or indexes
returns0	Computes untrimmed returns from prices or indexes
runlengths	Computes run lenghts of a 'timeSeries'
smooth	Smoothes a 'timeSeries'
splits	Detects 'timeSeries' splits by outlier detection
spreads	Computes spreads from a price/index stream
turns	Computes turning points in a 'timeSeries' object
turnsStats	Computes turning points statistics

Statistics Time Series functions

colCumsums	Computes cumulated column sums of a 'timeSeries'
colCummaxs	Computes cumulated maximum of a 'timeSeries'
colCummins	Computes cumulated minimum of a 'timeSeries'
colCumprods	Computes cumulated pruduct values by column
colCumreturns	Computes cumulated returns by column
colSums	Computes sums of all values in each column
colMeans	Computes means of all values in each column
colSds	Computes standard deviations of all values in each column
colVars	Computes variances of all values in each column
colSkewness	Computes skewness of all values in each column
colKurtosis	Computes kurtosis of all values in each column
colMaxs	Computes maxima of all values in each column
colMins	Computes minima of all values in each column
colProds	Computes products of all values in each column
colStats	Computes statistics of all values in each column
orderColnames	Returns ordered column names of a 'timeSeries'
sortColnames	Returns alphabetically sorted column names
sampleColnames	Returns sampled column names of a 'timeSeries'
pcaColnames	Returns PCA correlation ordered column names
hclustColnames	Returns hierarchically clustered columnames
statsColnames	Returns statisticall rearrange columnames
orderStatistics	Computes order statistics of a 'timeSeries' object
rollMean	Computes rolling means of a 'timeSeries' object
rollMin	Computes rolling minima of a 'timeSeries' object
rollMax	Computes rolling maxima of a 'timeSeries' object
rollMedian	Computes rolling medians of a 'timeSeries' object
rollStats	Computes rolling statistics of a 'timeSeries' objectcr
rowCumsums	Computes cumulated column sums of a 'timeSeries'
smoothLowess	Smoothes a series with lowess function
smoothSupsmu	Smoothes a series with supsmu function
smoothSpline	Smoothes a series with smooth.spline function

Misc Functions

dummyDailySeries	Creates a dummy daily 'timeSeries' object
isMonthly	Decides if the series consists of monthly records
getArgs	Extracts arguments from a S4 method

aggregate-methods *timeSeries Class, Functions and Methods*

Description

Aggregates a 'timeSeries' Object.

Usage

```
## S4 method for signature 'timeSeries'
aggregate(x, by, FUN, ...)

daily2monthly(x, init=FALSE)
daily2weekly(x, startOn="Tue", init=FALSE)
```

Arguments

x	an object of class 'timeSeries'.
by	a sequence of timeDate objects denoting the aggregation period.
FUN	the function to be applied.
startOn	a string value, specifying the day of week as a three letter abbreviation. Weekly aggregated data records are then fixed to the weekdays given by the argument startOn.
init	a logical value, if set to TRUE then the time series will be indexed to 1 for its first value. By default init is set to FALSE.
...	arguments passed to other methods.

Details

The function aggregate is a function which can aggregate time series on general aggregation periods.

In addition there are two tailored function for simple usage: Function daily2monthly and daily2weekly which allow to aggregate 'timeSeries' objects from daily to monthly or weekly levels, respectively.

In the case of the function daily2weekly one can explicitely the starting day of the week, the default value is Tuesday, startOn="Tue".

Value

aggregate returns an aggregated S4 object of class timeSeries.

daily2monthly returns an aggregated monthly object of class timeSeries.

daily2weekly returns an aggregated weekly object of class timeSeries starting on the specified day of week.

Examples

```
## Load Microsoft Data Set -
   x <- MSFT

## Aggregate by Weeks -
   by <- timeSequence(from = start(x),  to = end(x), by = "week")
   aggregate(x, by, mean)

## Aggregate to Last Friday of Month -
   by <- unique(timeLastNdayInMonth(time(x), 5))
   X <- aggregate(x, by, mean)
   X
   dayOfWeek(time(X))
   isMonthly(X)

## Aggregate to Last Day of Quarter -
   by <- unique(timeLastDayInQuarter(time(x)))
   X <-  aggregate(x, by, mean)
   X
   isQuarterly(X)

## Aggregate daily records to end of month records -
   X <- daily2monthly(x)
   X
   isMonthly(X)

## Aggregate da, ily records to end of week records -
   X <- daily2weekly(x, startOn="Fri")
   X
   dayOfWeek(time(X))
```

`align-methods` *timeSeries Class, Functions and Methods*

Description

Aligns a 'timeSeries' Object.

Usage

```
## S4 method for signature 'timeSeries'
align(x, by = "1d", offset = "0s",
    method = c("before", "after", "interp", "fillNA",
    "fmm", "periodic", "natural", "monoH.FC"),
    include.weekends = FALSE, ...)
```

Arguments

x	an object of class timeSeries.
by	a character string denoting the period
offset	a character string denoting the offset
method	a character string denoting the alignment approach.
include.weekends	a logical flag, should weekend be included.
...	Further arguments to be passed to the interpolating function.

Value

Returns an aligned S4 'timeSeries' object.

Examples

```
## Use MSFT and Compute Sample Size -
   dim(MSFT)

## Align the Series -
   MSFT.AL <- align(MSFT)

## Show the Size of the Aligned Series -
   dim(MSFT.AL)
```

---

apply *Apply Functions Over Time Series Periods*

Description

Applies a function to a 'timeSeries' object over time peridos of arbitrary positons and lengths.

Usage

```
fapply(x, from, to, FUN, ...)

applySeries(x, from = NULL, to = NULL, by = c("monthly", "quarterly"),
    FUN = colMeans, units = NULL, format = x@format, zone = x@FinCenter,
    FinCenter = x@FinCenter, recordIDs = data.frame(), title = x@title,
    documentation = x@documentation, ...)
```

Arguments

x	an object of class timeSeries.
from, to	starting date and end date as timeDate objects. Note, to must be time ordered after from. If from and to are missing in function fapply they are set by default to from=start(x), and to=end(x).

FUN	the function to be applied. For the function applySeries the default setting is FUN=colMeans.
by	a character value either "monthly" or "quarterly" used in the function applySeries. The default value is "monthly". Only operative when both arguments from and to have their default values NULL. In this case the function FUN will be applied to monthly or quarterly periods.
units	an optional character string, which allows to overwrite the current column names of a timeSeries object. By default NULL which means that the column names are selected automatically.
format	the format specification of the input character vector in POSIX notation.
zone	the time zone or financial center where the data were recorded.
FinCenter	a character value with the the location of the financial center named as "continent/city", or "city".
recordIDs	a data frame which can be used for record identification information. Note, this is not yet handled by the apply functions, an empty data.frame will be returned.
title	an optional title string, if not specified the inputs data name is deparsed.
documentation	optional documentation string, or a vector of character strings.
...	arguments passed to other methods.

Details

Like apply applies a function to the margins of an array, the function fapply applies a function to the time stamps or signal counts of a financial (therefore the "f" in front of the function name) time series of class 'timeSeries'.

The function fapply inputs a timeSeries object, and if from and to are missing, they take the start and end time stamps of the series as default falues. The function then behaves like apply on the column margin.

Note, the function fapply can be used repetitive in the following sense: If from and to are two timeDate vectors of equal length then for each period spanned by the elelemts of the two vectors the function FUN will be applied to each period. The resulting time stamps, are the time stamps of the to vector. Note, the periods can be regular or irregelar, and they can even overlap.

The function fapply calls the more general function applySeries which also offers, to create automatical monthly and quarterly periods.

Examples

```
## Percentual Returns of Swiss Bond Index and Performance Index -
   LPP <- 100 * LPP2005REC[, c("SBI", "SPI")]
   head(LPP, 20)

## Aggregate Quarterly Returns -
   applySeries(LPP, by = "quarterly", FUN = colSums)

## Aggregate Quarterly every last Friday in Quarter -
   oneDay <- 24*3600
   from <- unique(timeFirstDayInQuarter(time(LPP))) - oneDay
```

```
   from <- timeLastNdayInMonth(from, nday = 5)
   to <- unique(timeLastDayInQuarter(time(LPP)))
   to <- timeLastNdayInMonth(to, nday = 5)
   data.frame(from = as.character(from), to = as.character(to))
   applySeries(LPP, from, to, FUN = colSums)

## Count Trading Days per Month -
   colCounts <- function(x) rep(NROW(x), times = NCOL(x))
   applySeries(LPP, FUN = colCounts, by = "monthly")

## Alternative Use -
   fapply(LPP, from, to, FUN = colSums)
```

---

as *timeSeries Class, Coercion and Transformation*

Description

Functions and methods dealing with the coercion of 'timeSeries' objects.

Usage

```
## Default S3 method:
as.timeSeries(x, ...)
## S3 method for class 'ts'
as.timeSeries(x, ...)
## S3 method for class 'data.frame'
as.timeSeries(x, ...)
## S3 method for class 'character'
as.timeSeries(x, ...)
## S3 method for class 'zoo'
as.timeSeries(x, ...)

## S4 method for signature 'timeSeries'
as.matrix(x, ...)
## S4 method for signature 'timeSeries'
as.ts(x, ...)
## S4 method for signature 'timeSeries'
as.data.frame(x, row.names = NULL, optional = FALSE, ...)
## S4 method for signature 'timeSeries'
as.ts(x, ...)
```

Arguments

optional	A logical value. If TRUE, setting row names and converting column names (to syntactic names) is optional.
row.names	NULL or a character vector giving the row names for the data frame. Missing values are not allowed.

x	an object which is coerced according to the generic function.
...	arguments passed to other methods.

Details

Functions to create 'timeSeries' objects from other objects:

as.timeSeries	Generic to convert an object to a 'timeSeries',
as.timeSeries.default	Returns the unchanged object,
as.timeSeries.numeric	Converts from a numeric vector,
as.timeSseries.data.frame	Converts from a numeric vector,
as.timeSeries.matrix	Converts from a matrix,
as.timeSeries.ts	Converts from an object of class 'ts',
as.timeSeries.character	Converts from a named demo file,
as.timeSeries.zoo	Converts an object of class zoo.

Functions to transform 'timeSeries' objects into other objects:

as.matrix.timeSeries	Coerces a 'timeSeries' to a matrix,
as.data.frame.timeSeries	Coerces a 'timeSeries' to a data.frame,
as.ts.timeSeries	S3: Coerces a 'timeSeries' to a 'ts' object.
as.ts.timeSeries	S3: Coerces a 'timeSeries' to a 'logical' object.

Value

Function as.timeSeries returns a S4 object of class 'timeSeries'.

Functions as.numeric, as.data.frame, as.matrix, as.ts return depending on the generic function a numeric vector, a data frame, a matrix, or an object of class ts.

Examples

```
## Create an Artificial timeSeries Object -
   setRmetricsOptions(myFinCenter = "GMT")
   charvec <- timeCalendar()
   data <- matrix(rnorm(12))
   TS <- timeSeries(data, charvec, units = "RAND")
   TS

## Coerce to Vector -
   as.vector(TS)

## Coerce to Matrix -
   as.matrix(TS)

## Coerce to Data Frame -
   as.data.frame(TS)
```

attach *Attach a timSeries to the search path*

Description

Attaches a 'timeSeries' object to the search path.

Usage

```
## S4 method for signature 'timeSeries'
attach(what, pos = 2, name = deparse(substitute(what)),
    warn.conflicts = TRUE)
```

Arguments

name	alternative way to specify the database to be attached. See for details help(attach,package=base).
pos	an integer specifying position in search() where to attach the database. See for details help(attach,package=base).
warn.conflicts	a logical value. If TRUE, warnings are printed about conflicts from attaching the database, unless that database contains an object .conflicts.OK. A conflict is a function masking a function, or a non-function masking a non-function. See for details help(attach,package=base).
what	[attach] - database to be attached. This may currently be a timeSeries object, a data.frame or a list or a R data file created with save or NULL or an environment. See for details help(attach,package=base).

Value

The environment is returned invisibly with a name attribute.

Note

Note, the function detach from the base package can be used to detach the attached objects.

Examples

```
## Load Microsoft Data Set -
   x <- MSFT[1:10, ]
   colnames(x)

## Attach the Series and Compute the Range -
   attach(x)
   range <- High - Low
   range

## Convert Vector to a timeSeries Object -
```

```
   timeSeries(data=range, charvec=time(x), units="Range")

## Detach the series from the search path -
   detach("x")
   ans <- try(High, silent=TRUE)
   cat(ans[1])
```

---

attributes *Get and Set Optional Attributes of a 'timeSeries'*

Description

Extracts or assigns optional attributes from or to a `timeSeries` object.

Usage

```
getAttributes(obj)
setAttributes(obj) <- value
```

Arguments

`obj`	a `timeSeries` object whose optional attributes are to be accessed.
`value`	an object, the new value of the attribute, or NULL to remove the attribute.

Details

Each `timeSeries` object is documented. By default a time series object holds in the documentation slot a string with creation time and the user who has defined it. But this is not all. Optionally the whole creation process and history can be recorded. For this the `@documentation` slot may have an optional `"Attributes"` element. This attribute is tracked over the whole life time of the object whenever the time series is changed. Whenever you like to be informed about the optional attributes, or you like to recover them you can dot it, and evenmore, whenever you like to add information as an addiitonal attribute you can also do it.

The two functions `getAttributes` and `setAttributes` provide access to and allow to modify the optional attributes of a `timeSeries` object.

Examples

```
## Create an artificial timeSeries Object -
   tS <- dummySeries()
   tS

## Get Optional Attributes -
   getAttributes(tS)
   tS@documentation

## Set a new Optional Attribute -
   setAttributes(tS) <- list(what="A dummy Series")
```

```
tS
getAttributes(tS)
tS@documentation
```

---

base-methods *Methods for 'timeSeries' object*

Description

Methods for function in Package 'base' for `timeSeries` object.

Methods

x = "timeSeries" a `timeSeries` object.

Examples

```
## None -
```

---

bind *Bind two timeSeries objects*

Description

Binds two 'timeSeries' objects either by column or by row.

Value

returns a S4 object of class `timeDate`.

Examples

```
## Load Microsoft Data Set -
   x <- MSFT[1:12, ]
   x

## Bind Columnwise -
   X <- cbind(x[, "Open"], returns(x[, "Open"]))
   colnames(X) <- c("Open", "Return")
   X

## Bind Rowwise -
   Y <- rbind(x[1:3, "Open"], x[10:12, "Open"])
   Y
```

colCum *Cumulated Column Statistics*

Description

Functions to compute cumulative column statistics.

Usage

```
## S4 method for signature 'timeSeries'
colCumsums(x, na.rm = FALSE, ...)

## S4 method for signature 'timeSeries'
colCummaxs(x, na.rm = FALSE, ...)

## S4 method for signature 'timeSeries'
colCummins(x, na.rm = FALSE, ...)

## S4 method for signature 'timeSeries'
colCumprods(x, na.rm = FALSE, ...)

## S4 method for signature 'timeSeries'
colCumreturns(x, method = c("geometric", "simple"), na.rm = FALSE, ...)
```

Arguments

method	a character string to indicate if geometric (TRUE) or simple (FALSE) returns should be computed.
na.rm	a logical. Should missing values be removed?
x	a time series, may be an object of class "matrix", or "timeSeries".
...	arguments to be passed.

Value

all functions return an S4 object of class timeSeries.

Examples

```
## Simulated Return Data -
   x = matrix(rnorm(24), ncol = 2)

## Cumulative Sums Column by Column  -
   colCumsums(x)
```

colStats *Column Statistics*

Description

A collection and description of functions to compute column statistical properties of financial and economic time series data.

The functions are:

colStats	calculates column statistics,
colSums	calculates column sums,
colMeans	calculates column means,
colSds	calculates column standard deviations,
colVars	calculates column variances,
colSkewness	calculates column skewness,
colKurtosis	calculates column kurtosis,
colMaxs	calculates maximum values in each column,
colMins	calculates minimum values in each column,
colProds	computes product of all values in each column,
colQuantiles	computes quantiles of each column.

Usage

```
colStats(x, FUN, ...)

colSds(x, ...)
colVars(x, ...)
colSkewness(x, ...)
colKurtosis(x, ...)
colMaxs(x, ...)
colMins(x, ...)
colProds(x, ...)
colQuantiles(x, prob = 0.05, ...)

colStdevs(x, ...)
colAvgs(x,  ...)
```

Arguments

FUN	a function name. The statistical function to be applied.
prob	a numeric value, the probability with value in [0,1].

x	a rectangular object which can be transformed into a matrix by the function as.matrix.
...	arguments to be passed.

Value

the functions return a numeric vector of the statistics.

See Also

link{rowStats}.

Examples

```
## Simulated Return Data in Matrix Form -
   x = matrix(rnorm(252), ncol = 2)

## Mean Columnwise Statistics -
   colStats(x, FUN = mean)

## Quantiles Column by Column -
   colQuantiles(x, prob = 0.10, type = 1)
```

---

comment *comment for timeSeries objects*

Description

Print or assign new comment to a timeSeries object.

Usage

```
## S4 method for signature 'timeSeries'
comment(x)
## S4 replacement method for signature 'timeSeries'
comment(x) <- value
```

Arguments

x	a timeSeries object.
value	a character string - the comment.

Examples

```
## Get Description from timeSeries -
   comment(LPP2005REC)

## Add User to comment -
   comment(LPP2005REC) <- paste(comment(LPP2005REC), "by User Rmetrics")
   comment(LPP2005REC)
```

`cumulated` *Cumulated Time Series from Returns*

Description

Computes a cumulated financial 'timeSeries', e.g. prices or indexes, from financial returns.

Usage

```
cumulated(x, ...)

## Default S3 method:
cumulated(x, method = c("continuous", "discrete",
    "compound", "simple"), percentage = FALSE, ...)
```

Arguments

`method`	a character string naming the method how the returns were computed.
`percentage`	a logical value. By default `FALSE`, if `TRUE` the series will be expressed in percentage changes.
`x`	an object of class `timeSeries`.
`...`	arguments to be passed.

Details

Note, the function `cumulated` assumes as input discrete returns from a price or index series. Only then the cumulatrd series agrees with the original price or index series. The first values of the cumulated series cannot be computed, it is assumed that the series is indexed to 1.

Value

Returns a 'timeSeries' object of the same class as the input argument `x`.

Examples

```
## Use the Microsofts' Close Prices Indexed to 1 -
   MSFT.CL <- MSFT[, "Close"]
   MSFT.CL <- MSFT.CL/MSFT[[1, "Close"]]
   head(MSFT.CL)

## Compute Discrete Return -
   MSFT.RET <- returns(MSFT.CL, method = "discrete")

## Cumulated Series and Compare -
   MSFT.CUM <- cumulated(MSFT.RET, method = "discrete")
   head(cbind(MSFT.CL, MSFT.CUM))
```

`DataPart,timeSeries-method` *DataPart,timeSeries-method*

Description

Utilities called to implement object@.Data of `timeSeries` objects.

Examples

```
## Load Microsoft Data -
   X <- MSFT[1:10, 1:4]

## Get Data Part -
   DATA <- getDataPart(X)
   class(DATA)
```

`description` *Creates Date and User Information*

Description

Creates and returns a data and user string.

Usage

```
description()
```

Examples

```
## Show Default Description String -
   description()
```

diff *diff*

Description

Differences a 'timeSeries' 0bject.

Usage

```
diff(x, ...)
```

Arguments

x	an object of class 'timeSeries'.
...	further arguments to be passed. These may include

Details

Arguments to be passed may include:

lag - an integer indicating which lag to use. By default 1.
diff - an integer indicating the order of the difference. By default 1.
trim - a logical flag. Should NAs at the beginning of the series be removed? By default FALSE.
pad - a umeric value with which NAs should be replaced at the beginning of the series. By default NA.

Value

Returns a differenced S4 'timeSeries' object.

Examples

```
## Load Microsoft Data Set -
   x <- MSFT[1:12, ]
   x

## Compute Differences -
   diff(x)

## Trimmed Differences -
   diff(x, trim=TRUE)

## Padded Differences -
   diff(x, trim=FALSE, pad=0)
```

dimnames *Time Series Columns and Rows*

Description

Handling columns and rows of 'timeSeries' objects.

Details

dim	Returns the dimension of a 'timeSeries' object
dimnames	Returns the dimension names of a 'timeSeries' object
colnames<-	Assigns column names to a 'timeSeries' object
rownames<-	Assigns row names to a 'timeSeries' object

Value

Returns the dimensions and related numbers of a 'timeSeries' object.

Examples

```
## Load Swiss Pension Fund Benchmark Data -
   X <- LPP2005REC[1:10, 1:3]

## Get Dimension -
   dim(X)

## Get Column and Row Names -
   dimnames(X)

## Get Column / Row Names -
   colnames(X)
   rownames(X)

## Try your own DIM -
   DIM <- function(x) {c(NROW(x), NCOL(x))}
   DIM(X)
   DIM(X[, 1])

## Try length / LENGTH -
   length(X)
   length(X[, 1])
   LENGTH <- function(X) NROW(X)
   LENGTH(X)

## Columns / Rows -
   ncol(X); NCOL(X)
```

```
   nrow(X); NROW(X)

## See also -
   isUnivariate(X)
   isMultivariate(X)
```

---

drawdowns *Calculations of Drawdowns*

Description

Compute series of drawdowns from financial returns and calculate drawdown statisitcs.

Usage

```
drawdowns(x, ...)

drawdownsStats(x, ...)
```

Arguments

x	a 'timeSeries' object of financial returns. Note, drawdowns can be calculated from an uni- or multivariate time deries object, statistics can only be computed from an univariate time series object.
...	optional arguments passed to the function na.omit.

Details

The code in the core of the function drawdownsStats was was borrowed from the package PerformanceAnalytics authored by Peter Carl and Sankalp Upadhyay.

Value

drawdowns
returns an object of class 'timeSeries'.

drawdownsStats
returns an object of class 'data.frame' with the following entries:
"drawdown" - the depth of the drawdown,
"from" - the start date,
"trough" - the trough period,
"to" - the end date,
"length" - the length in number of records,
"peaktrough" - the peak trough, and ,
"recovery" - the recovery length in number of records.

Author(s)

Peter Carl and Sankalp Upadhyay for code from the contributed R package PerformanceAnalytics used in the function drawdownsStats.

Examples

```
## Use Swiss Pension Fund Data Set of Returns -
   head(LPP2005REC)
   SPI <- LPP2005REC[, "SPI"]
   head(SPI)

## Plot Drawdowns -
   dd = drawdowns(LPP2005REC[, "SPI"], main = "Drawdowns")
   plot(dd)
   dd = drawdowns(LPP2005REC[, 1:6], main = "Drawdowns")
   plot(dd)

## Compute Drawdowns Statistics -
   ddStats <- drawdownsStats(SPI)
   class(ddStats)
   ddStats

## Note, Only Univariate Series are allowd -
   ddStats <- try(drawdownsStats(LPP2005REC))
   class(ddStats)
```

`durations` *Durations from a Time Series*

Description

Computes durations from an object of class 'timeSeries'.

Usage

```
durations(x, trim = FALSE, units = c("secs", "mins", "hours", "days"))
```

Arguments

`x`	an object of class `timeSeries`.
`trim`	a logical value. By default `TRUE`, the first missing observation in the return series will be removed.
`units`	a character value or vector which allows to set the units in which the durations are measured. By default durations are measured in seconds.

Details

Durations measure how long it takes until we get the next record in a `timesSeries` object. We return a time series in which for each time stamp we get the length of the period from when we got the last record. This period is measured in length specified by the argument `units`, for daily data use `units="days"`.

Value

returns an object of class `timeSeries`.

Examples

```
## Compute Durations in days for the MSFT Sereries -
   head(durations(MSFT, units = "days"))
   head(durations(MSFT, trim = TRUE, units = "days"))

## The same in hours -
   head(durations(MSFT, trim = TRUE, units = "hours"))
```

---

filter *Linear Filtering on a Time Series*

Description

Applies linear filtering to a univariate 'timeSeries'.

Value

A 'timeSeries' object without missing values.

Examples

```
## Creata a Dummy Signal 'timeSeries' -
   data <- matrix(rnorm(100), ncol = 2)
   s <- timeSeries(data, units=c("A", "B"))
   head(s)

## Filter the series -
   f <- filter(s, rep(1, 3))
   head(f)

## Plot and Compare the first series -
   plot(cbind(s[, 1], f[, 1]), plot.type="s")
```

---

finCenter *Get and Set Financial Center of a 'timeSeries'*

Description

Print or assign new financial center to a 'timeSeries' object.

Usage

```
getFinCenter(x)
setFinCenter(x) <- value

## S4 method for signature 'timeSeries'
finCenter(x)
## S4 replacement method for signature 'timeSeries'
finCenter(x) <- value
```

Arguments

x	a 'timeSeries' object.
value	a character with the the location of the financial center named as "continent/city".

See Also

listFinCenter

Examples

```
## An artificial timeSeries Object -
   tS <- dummySeries()
   tS

## Print Financial Center -
   finCenter(tS)
   getFinCenter(tS)

## Assign New Financial Center -
   finCenter(tS) <- "Zurich"
   tS
   setFinCenter(tS) <- "New_York"
   tS
```

---

is.timeSeries *timeSeries Class, Coercion and Transformation*

Description

`is.timeSeries` tests if its argument is a `timeSeries`. `is.timeSeries` tests if series has no timestamps.

Usage

```
is.timeSeries(x)
is.signalSeries(x)
```

Arguments

x	an object of class 'timeSeries'.

Value

Returns TRUE or FALSE depending on whether its argument is an object of class 'timeSeries' or not.

Examples

```
## Create an Artificial timeSeries Object -
   setRmetricsOptions(myFinCenter = "GMT")
   charvec <- timeCalendar()
   data <- matrix(rnorm(12))
   TS <- timeSeries(data, charvec, units = "RAND")
   TS

## Test for timeSeries -
   is.timeSeries(TS)
```

---

isRegular *Checks if a time series is regular*

Description

Checks if a time series is regular.

Usage

```
## S4 method for signature 'timeSeries'
isDaily(x)
## S4 method for signature 'timeSeries'
isMonthly(x)
## S4 method for signature 'timeSeries'
isQuarterly(x)

## S4 method for signature 'timeSeries'
isRegular(x)

## S4 method for signature 'timeSeries'
frequency(x, ...)
```

Arguments

x	an R object of class 'timeSeries'.
...	arguments to be passed.

Details

What is a regular time series? If a series is a daily, a monthly, or a weekly time series then we speak of a regular series. This can be tested calling the functions `isDaily`, `isMonthly`, `isQuarterly`, or in general `isRegular` If the series is regular then the frequency of the series can be determined calling the function `frequency`.

A time series is defined as daily if the series has not more than one date/time stamp per day.
A time series is defined as monthly if the series has not more than one date/time stamp per month.
A time series is defined as quarterly if the series has not more than one date/time stamp per quarter.
Note, amonthly series is also a daily series, a quarterly series is alsona monthly series.
With these definitions a regular series is either a monthly or a quarterly series.

NOT yet implemented is the case of weekly series.

Value

The `is*` functions return `TRUE` or `FALSE` depending on whether the series fulfills the condition or not.

The function frequency returns in general 1, for quarterly series 4, and for monthly series 12.

Examples

```
## None
```

---

isUnivariate *Checks if a Time Series is Univariate*

Description

Checks if a time series o bject or any other rectangular object is univariate or multivariate.

Usage

```
isUnivariate(x)
isMultivariate(x)
```

Arguments

`x`	an object of class `timeSeries` or any other rectangular object.

Details

A rectangular object `x` is considered to be univariate if the function `NCOL(x)` returns one, and is considered to be multivariate if `NCOL(x)` returns a value bigger than one.

Value

isUnivariate
isMultivariate

return a logical depending if the test is true or not.

Examples

```
## Load Microsoft Data -
   setRmetricsOptions(myFinCenter = "GMT")
   data(MSFT)
   Open = MSFT[, "Open"]

## Is the timeSeries Univariate -
   isUnivariate(MSFT)
   isUnivariate(Open)

## Is the timeSeries Multivariate -
   isMultivariate(MSFT)
   isMultivariate(Open)
```

---

lag *Lag a Time Series*

Description

Compute a lagged version of a 'timeSeries' object.

Usage

```
## S4 method for signature 'timeSeries'
lag(x, k = 1, trim = FALSE, units = NULL, ...)
```

Arguments

k	[lagSeries] - an integer value. The number of lags (in units of observations). By default 1.
trim	a logical value. By default TRUE, the first missing observation in the return series will be removed.
units	an optional character string, which allows to overwrite the current column names of a timeSeries object. By default NULL which means that the column names are selected automatically.
x	an object of class timeSeries.
...	arguments passed to other methods.

Value

returns a lagged S4 object of class 'timeSeries'.

Examples

```
## Load Micsrosoft Data Set -
   x = MSFT[1:20, "Open"]

## Lag the timeSeries Object:
   lag(x, k = -1:1)
```

`math` *Mathematical Time Series Operations*

Description

Functions and methods dealing with mathematical 'timeSeries' operations.

Usage

```
## S4 method for signature 'timeSeries'
quantile(x, ...)
```

Arguments

`x`	an object of class `timeSeries`.
`...`	arguments to be passed.

Details

The math functions include:

`Ops-method`	Group 'Ops' methods for a 'timeSeries' object
`Math-method`	Group 'Math' methods for a 'timeSeries' object
`Math2-method`	Group 'Math2' methods for a 'timeSeries' object
`Summary-method`	Group 'Summary' methods for a 'timeSeries' object
`quantile`	Returns quantiles of an univariate 'timeSeries'.

Value

Returns the value from a mathematical or logical operation operating on objects of class 'timeSeries[], or the value computed by a mathematical function.

Examples

```
## Create an Artificial timeSeries Object -
   setRmetricsOptions(myFinCenter = "GMT")
   charvec = timeCalendar()
   set.seed(4711)
   data = matrix(exp(cumsum(rnorm(12, sd = 0.1))))
   TS = timeSeries(data, charvec, units = "TS")
   TS

## Mathematical Operations: | +/- * ^ ... -
   TS^2
   TS[2:4]
   OR = returns(TS)
   OR
   OR > 0
```

`merge` *Merges two 'timeSeries' objects*

Description

Merges several object types with 'timeSeries' objects. The number of rows must match.

Details

The following combinations are supported:

`timeSeries`	ANY
`timeSeries`	missing
`timeSeries`	numeric
`timeSeries`	matrix
`timeSeries`	timeSeries

Value

Returns a 'timeSeries' object of two merged time series.

Examples

```
## Load Series -
   x <- MSFT[1:12, ]

## Merge 'timeSeries' with missing Object -
   merge(x)

## Merge 'timeSeries' with numeric Object -
   y <- rnorm(12)
   class(y)
   merge(x, y)
```

```
## Merge 'timeSeries' with matrix Object -
   y <- matrix(rnorm(24), ncol=2)
   class(y)
   merge(x, y)

## Merge 'timeSeries' with matrix Object -
   y <- timeSeries(data=rnorm(12), charvec=time(x))
   class(y)
   merge(x, y)
```

`model.frame` *Model Frames for Time Series Objects*

Description

Allow to work with model frames for 'timeSeries' objects.

Details

The function `model.frame` is a generic function which returns in the R-ststs framework by default a data.frame with the variables needed to use `formula` and any `...` arguments. In contrast to this the method returns an object of class `timeSeries` when the argument data was not a `data.frame` but also an object of class 'timeSeries'.

Value

Returns an object of class 'timeSeries.

Note

This function is preliminary and untested.

See Also

`model.frame`.

Examples

```
## Load Microsoft Data -
   setRmetricsOptions(myFinCenter = "GMT")
   X <- MSFT[1:12, ]

## Extract High's and Low's:
   DATA <- model.frame( ~ High + Low, data = X)
   class(DATA)
   as.timeSeries(DATA)

## Extract Open Prices and their log10's:
```

```
base <- 10
Open <- model.frame(Open ~ log(Open, base = `base`), data = X)
colnames(Open) <- c("X", "log10(X)")
class(Open)
as.timeSeries(Open)
```

---

monthly *Special Monthly Series*

Description

Functions and methods dealing with special monthly 'timeSeries' objects.

Usage

```
countMonthlyRecords(x)

rollMonthlyWindows(x, period = "12m", by = "1m")
rollMonthlySeries(x, period = "12m", by = "1m", FUN, ...)
```

Arguments

x	a 'timeSeries' object.
period	a character string specifying the rollling period composed by the length of the period and its unit. As examples: "3m" represents quarterly shifts, and "6m",]code"12m", and "24m" semi-annual, annual and bi-annual shifts. To determine the proper start of the series is in the responsibility of the user.
by	a character string specifying the rolling shift composed by the length of the shift and its unit. As examples: "1m" represents monthly shifts, "3m" represents quarterly shifts, and "6m" semi-annual shifts. To determine the proper start of the series is in the responsibility of the user.
FUN	the function for the statistic to be applied. For example in the case of aggregation usecolAvgs.
...	arguments passed to the function FUN.

Details

The function countMonthlyRecords computes a 'timeSeries' that holds the number of monthly counts of the records.

The function rollMonthlyWindows computes start and end dates for rolling time windows.

The function rollMonthlySeries computes a static over rolling periods defined by the function rollMonthlyWindows.

Value

The function countMonthlyRecords returns a 'timeSeries' object.

The function rollMonthlyWindows returns a list with two named 'tomeDate' entries: $from and to. An attribute "control" is added which keeps the start and end dates of the series.

The function rollMonthlySeries computes the statistics defined by the function FUN over a rolling window internally computed by the function rollMonthlyWindows. Note, the periods may be overlapping, may be dense, or even may have gaps.

Examples

```
## Load Microsoft Daily Data Set:
   x <- MSFT

## Count Monthly Records -
   counts <- countMonthlyRecords(x)
   counts

## Quaterly Non-Overlapping Time Periods -
   windows <- rollMonthlyWindows(counts[-1, ], period = "3m", by = "3m")
   windows

## Nicely Reprint Results as a data.frame -
   data.frame(cbind(FROM=format(windows$from), TO=format(windows$to)))

## Compute the average number of monthly trading days per quarter -
   rollMonthlySeries(counts[-1, ], period = "3m", by = "3m", FUN=mean)
```

---

na *Handling Missing Time Series Values*

Description

Functions for handling missing values in 'timeSeries' objects

Usage

```
## S4 method for signature 'timeSeries'
na.omit(object, method = c("r", "s", "z", "ir", "iz", "ie"),
    interp = c("before", "linear", "after"), ...)

removeNA(x, ...)
substituteNA(x, type = c("zeros", "mean", "median"), ...)
interpNA(x, method = c("linear", "before", "after"), ...)
```

Arguments

interp, type	[nna.omit][substituteNA] - Three alternative methods are provided to remove NAs from the data: type="zeros" replaces the missing values by zeros, type="mean" replaces the missing values by the column mean, type="median" replaces the missing values by the the column median.
method	[na.omit] - Specifies the method how to handle NAs. One of the applied vector strings: method="s" na.rm = FALSE, skip, i.e. do nothing, method="r" remove NAs, method="z" substitute NAs by zeros, method="ir" interpolate NAs and remove NAs at the beginning and end of the series, method="iz" interpolate NAs and substitute NAs at the beginning and end of the series, method="ie" interpolate NAs and extrapolate NAs at the beginning and end of the series, [interpNA] - Specifies the method how to interpolate the matrix column by column. One of the applied vector strings: method="linear", method="before" or method="after". For the interpolation the function approx is used.
object	an object of class("timeSeries").
x	a numeric matrix, or any other object which can be transformed into a matrix through x = as.matrix(x,...). If x is a vector, it will be transformed into a one-dimensional matrix.
...	arguments to be passed to the function as.matrix.

Details

Functions for handling missing values in 'timeSeries' objects and in objects which can be transformed into a vector or a two dimensional matrix.

The functions are listed by topic.

na.omit	Handles NAs,
removeNA	Removes NAs from a matrix object,
substituteNA	substitute NAs by zero, the column mean or median,
interpNA	interpolates NAs using R's "approx" function.

Missing Values in Price and Index Series:

Applied to timeSeries objects the function removeNA just removes rows with NAs from the series. For an interpolation of time series points one can use the function interpNA. Three different methods of interpolation are offered: "linear" does a linear interpolation, "before" uses the previous value, and "after" uses the following value. Note, that the interpolation is done on the index scale and not on the time scale.

Missing Values in Return Series:

For return series the function substituteNA may be useful. The function allows to fill missing values either by method="zeros", the method="mean" or the method="median" value of the appropriate columns.

Note

The functions removeNA, substituteNA and interpNA are older implementations. Please use in all cases if possible the new function na.omit.

When dealing with daily data sets, there exists another function alignDaily Series which can handle missing data in un-aligned calendarical 'timeSeries' objects.

References

Troyanskaya O., Cantor M., Sherlock G., Brown P., Hastie T., Tibshirani R., Botstein D., Altman R.B., (2001); *Missing Value Estimation Methods for DNA microarrays* Bioinformatics 17, 520–525.

Examples

```
## Create a Matrix -
   X <- matrix(rnorm(100), ncol = 5)

## Replace a Single NA Inside -
   X[3, 5] <- NA

## Replace Three in a Row Inside -
   X[17, 2:4] <- c(NA, NA, NA)

## Replace Three in a Column Inside -
   X[13:15, 4] <- c(NA, NA, NA)

## Replace Two at the Right Border -
   X[11:12, 5] <- c(NA, NA)

## Replace One in the Lower Left Corner -
   X[20, 1] <- NA
   print(X)

## Remove Rows with NAs -
   removeNA(X)

## Subsitute NA's by Zeros or Column Means -
   substituteNA(X, type = "zeros")
   substituteNA(X, type = "mean")

## Interpolate NA's Linearily -
   interpNA(X, method = "linear")
   # Note the corner missing value cannot be interpolated!

## Take Previous Values in a Column -
   interpNA(X, method = "before")
   # Also here, the corner value is excluded
```

na.contiguous *Find Longest Contiguous Stretch of non-NAs*

Description

Find the longest consecutive stretch of non-missing values in a timeSeries object. (In the event of a tie, the first such stretch.)

Usage

```
## S4 method for signature 'timeSeries'
na.contiguous(object, ...)
```

Arguments

object	a timeSeries object.
...	further arguments passed to or from other methods.

Value

A timeSeries object without missing values.

Examples

```
## Dummy timeSeries with NAs entries
   data <- matrix(sample(c(1:20, rep(NA,4))), ncol = 2)
   s <- timeSeries(data, timeCalendar())

## Find the longest consecutive non-missing values
   na.contiguous(s)
```

orderColnames *Reorder Column Names of a Time Series*

Description

Functions and methods dealing with the rearrangement of column names of 'timeSeries' objects.

orderColnames	Returns ordered column names of a time Series,
sortColnames	Returns sorted column names of a time Series,
sampleColnames	Returns sampled column names of a time Series,
statsColnames	Returns statistically rearranged column names,
pcaColnames	Returns PCA correlation ordered column names,
hclustColnames	Returns hierarchical clustered column names.

Usage

```
orderColnames(x, ...)
sortColnames(x, ...)
sampleColnames(x, ...)
statsColnames(x, FUN = colMeans, ...)
pcaColnames(x, robust = FALSE, ...)
hclustColnames(x, method = c("euclidean", "complete"), ...)
```

Arguments

FUN	a character string indicating which statistical function should be applied. By default statistical ordering operates on the column means of the time series.
method	a character string with two elements. The first determines the choice of the distance measure, see dist, and the second determines the choice of the agglomeration method, see hclust.
robust	a logical flag which indicates if robust correlations should be used.
x	an object of class timesSeries or any other rectangular object which can be transformed by the function as.matrix into a numeric matrix.
...	further arguments to be passed, see details.

Details

Statistically Motivated Rearrangement

The function statsColnames rearranges the column names according to a statical measure. These measure must operate on the columns of the time series and return a vector of values which can be sorted. Typical functions ar those listed in in help page colStats but one can also crete his own functions which compute for example risk or any other statistical measure. The ... argument allows to pass additional arguments to the underlying function FUN.

PCA Ordering of the Correlation Matrix

The function pcaColnames rearranges the column names according to the PCA ordered correlation matrix. The argument robust allsows to select between the use of the standard cor and computation of robust correlations using the function covMcd from contributed R package robustbase. The ... argument allows to pass additional arguments to the two underlying functions cor or covMcd. E.g. adding method="kendall" to the argument list calculates Kendall's rank correlations instead the default which calculates Person's correlations.

Ordering by Hierarchical Clustering

The function pcaColnames uses the hierarchical clustering approach hclust to rearrange the column names of the time series.

Value

returns a vector of character string, the rearranged column names.

Examples

```
## Load Swiss Pension Fund Benchmark Data -
   data <- LPP2005REC[,1:6]

## Abbreviate Column Names -
   colnames(data)

## Sort Alphabetically -
   sortColnames(data)

## Sort by Column Names by Hierarchical Clustering -
   hclustColnames(data)
   head(data[, hclustColnames(data)])
```

---

orderStatistics *order Statistics*

Description

Computes order statistic of a 'timeSeries'.

Usage

```
orderStatistics(x)
```

Arguments

x	an univariate 'timeSeries' object.

Value

Function `orderStatistics` returns the order statistic of an univariate 'timeSeries' object. The output is an object of class 'list'.

Examples

```
## Load Swiss Pension Fund Benchmark Data -
   setRmetricsOptions(myFinCenter = "GMT")
   X <- LPP2005REC[, "SPI"]
   colnames(X)

## Compute 1% Order Statistics -
   N <- round(0.01*nrow(X))
   N
   OS <- orderStatistics(X)[[1]]
   OS[1:N, ]
```

periodical *End-of-Period Series, Stats, and Benchmarks*

Description

Computes perodical statistics back to a given period.

Usage

```
endOfPeriodSeries(x,
    nYearsBack = c("1y", "2y", "3y", "5y", "10y", "YTD"))

endOfPeriodStats(x,
    nYearsBack = c("1y", "2y", "3y", "5y", "10y", "YTD"))

endOfPeriodBenchmarks(x, benchmark = ncol(x),
    nYearsBack = c("1y", "2y", "3y", "5y", "10y", "YTD"))
```

Arguments

x	an end-of-month recorded multivariate 'timeSeries' object. One of the columns holds the benchmark series specified by the argument benchmark, By defauklt this is the last column of x.
nYearsBack	a period string. How long back should the series be treated? Options include values from 1 year to 10 years, and year-to-date: "1y", "2y", "3y", "5y", "10y", "YTD".
benchmark	an integer giving the position of the benchmar series in x.

Details

The function endOfPeriodSeries returns series back to a given period.
The function endOfPeriodStats returns statistics back to a given period.
The function endOfPeriodBenchmarks returns benchmarks back to a given period.

x must be end of month data. Note you can create such series using for example the functions: align, alignDailySeries, daily2monthly.

Examples

```
## Load Series: Column 1:3 Swiss Market, Column 8 (4) Benchmark
   x <- 100 * LPP2005REC[, c(1:3, 8)]
   colnames(x)
   x <- daily2monthly(x)
   x

## Get the Monthly Series -
```

```
   endOfPeriodSeries(x, nYearsBack="1y")

## Compute the Monthly Statistics -
   endOfPeriodStats(x, nYearsBack="1y")

## Compute the Benchmark -
   endOfPeriodBenchmarks(x, benchmark=4)
```

---

plot-methods *Plot a Time Series*

Description

Plots 'timeSeries' objects and add lines and points.

Usage

```
## S4 method for signature 'timeSeries'
plot(x, y, FinCenter = NULL,
    plot.type = c("multiple", "single"), format = "auto",
    at = pretty(x), widths = 1, heights = 1, xy.labels,
    xy.lines, panel = lines, nc, yax.flip = FALSE,
    mar.multi = c(0, 5.1, 0, if (yax.flip) 5.1 else 2.1),
    oma.multi = c(6, 0, 5, 0), axes = TRUE, ...)

## S4 method for signature 'timeSeries'
lines(x, FinCenter = NULL, ...)
## S4 method for signature 'timeSeries'
points(x, FinCenter = NULL, ...)

## S3 method for class 'timeSeries'
pretty(x, n=5, min.n=n%/%3, shrink.sml=0.75,
    high.u.bias=1.5, u5.bias=0.5+1.5*high.u.bias, eps.correct=0, ...)
```

Arguments

x, y	objects of class timeSeries.
FinCenter	a character with the the location of the financial center named as "continent/city".
plot.type	for multivariate time series, should the series by plotted separately (with a common time axis) or on a single plot?
format	POSIX label format, e.g. "%Y-%m-%d" or "%F" for ISO-8601 standard date format.
at	a timeDate object setting the plot label positions. If at=pretty(x), the postitions are generated automatized calling the function pretty. Default option at="auto" selects 6 equal spaced time label positions. For the new plot themes set at="pretty" or at="chic". In this case additional arguments can be passed through the ... arguments, see details.

`widths, heights`
: widths and heights for individual graphs, see `layout`.

`xy.labels`
: logical, indicating if `text()` labels should be used for an x-y plot, _or_ character, supplying a vector of labels to be used. The default is to label for up to 150 points, and not for more.

`xy.lines`
: logical, indicating if `lines` should be drawn for an x-y plot. Defaults to the value of `xy.labels` if that is logical, otherwise to `TRUE`

`panel`
: a `function(x,col,bg,pch,type,...)` which gives the action to be carried out in each panel of the display for `plot.type="multiple"`. The default is `lines`.

`nc`
: the number of columns to use when `type="multiple"`. Defaults to 1 for up to 4 series, otherwise to 2.

`yax.flip`
: logical indicating if the y-axis (ticks and numbering) should flip from side 2 (left) to 4 (right) from series to series when `type="multiple"`.

`mar.multi, oma.multi`
: the (default) `par` settings for `plot.type="multiple"`.

`axes`
: logical indicating if x- and y- axes should be drawn.

`n`
: an integer giving the desired number of intervals.

`min.n`
: a nonnegative integer giving the minimal number of intervals.

`shrink.sml`
: a positive numeric by a which a default scale is shrunk in the case when range(x) is very small.

`high.u.bias`
: a non-negative numeric, typically > 1. Larger high.u.bias values favor larger units.

`u5.bias`
: a non-negative numeric multiplier favoring factor 5 over 2.

`eps.correct`
: an integer code, one of 0,1,2. If non-0, a correction is made at the boundaries.

`...`
: additional graphical arguments, see `plot`, `plot.default` and `par`.

Details

The original plotting function `plot` was build along R's plotting function `plot.ts` with an additional argument to tailor the position marks at user defined position specified by the argument `at`. We call this style or theme "ts".

With Verison R 3.1 we have inroduced two new additionol plotting themes called "pretty" and "chick". They are becoming active when we set `at="pretty"` or `at="chic"`.

Plot style or theme "pretty" is an extension of our original plotting function.

Plot style or theme "chic" an implementation along the contributed packages `xts` and `PerformanceAnalytics` from the Chicago finance group members. "Chicago" gave the name to call the them `"chic"`.

For both themes, "pretty" and "chic" additional arguments are passed through the `...` arguments. These are:

`Argument:`	Default:	Description:
`type`	"l"	types pf plot
`col`	1	colors for lines and points
`pch`	20	plot symbol
`cex`	1	character and symbol scales

lty	1	line types
lwd	2	line widths
cex.axes	1	scale of axes
cex.lab	1	scale of labels
cex.pch	1	scale of plot symbols
grid	TRUE	should grid lines plotted?
frame.plot	TRUE	should b box around the plot?
axes	TRUE	should be axes drawn on the plot?
ann	TRUE	should default annotations appear?

Concerning the plot elements, the length of these vectors has to be the same as the number of columns in the time series to be plotted. If their length is only one, then tey are repeated.

There is an almost 70 pages vignette added to the package, with dozens of examples of tailored plots. Have a look in it.

Value

Displays a plot or plot elements of an object of class 'timeSeries'.

Examples

```
## Load Swiss Pension Fund Benchmark Data -
   LPP <- LPP2005REC[1:12, 1:4]
   colnames(LPP) <- abbreviate(colnames(LPP), 2)
   finCenter(LPP) <- "GMT"

## Example Plot 1 -
   plot(LPP[, 1], type = "o", col = "steelblue",
     main = "LPP", xlab = "2005", ylab = "Return")
   plot(LPP[, 1], at="auto", type = "o", col = "steelblue",
     main = "LPP", xlab = "2005", ylab = "Return")

## Example Plot 2 -
   plot(LPP[, 1:2], type = "o", col = "steelblue",
     main = "LPP", xlab = "2005", ylab = "Return")

## Example Plot 3 -
   plot(LPP[, 1], LPP[, 2], type = "p", col = "steelblue",
     main = "LPP", xlab = "Return 1", ylab = "Return 2")

## Example Plot 4a, The Wrong Way to do it! -
   LPP <- as.timeSeries(data(LPP2005REC))
   ZRH <- as.timeSeries(LPP[,"SPI"], zone = "Zurich", FinCenter = "Zurich")
   NYC <- as.timeSeries(LPP[,"LMI"], zone = "NewYork", FinCenter = "NewYork")
   finCenter(ZRH)
   finCenter(NYC)
   plot(ZRH, at="auto", type = "p", pch = 19, col = "blue")
   points(NYC, pch = 19, col = "red")
```

```
## Example Plot 4b, Convert NYC to Zurich Time -
   finCenter(ZRH) <- "Zurich"
   finCenter(NYC) <- "Zurich"
   at <- unique(round(time(ZRH)))
   plot(ZRH, type = "p", pch = 19, col = "blue", format = "%b %d", at = at,
       xlab = paste(ZRH@FinCenter, "local Time"), main = ZRH@FinCenter)
   points(NYC, pch = 19, col = "red")

## Example 4c, Force Everything to GMT Using "FinCenter" Argument -
   finCenter(ZRH) <- "Zurich"
   finCenter(NYC) <- "NewYork"
   at <- unique(round(time(ZRH)))
   plot(ZRH, type = "p", pch = 19, col = "blue", format = "%b %d", at = at,
       FinCenter = "GMT", xlab = "GMT", main = "ZRH - GMT")
   points(NYC, FinCenter = "GMT", pch = 19, col = "red")
```

`print-methods` *Print a Time Series*

Description

Print 'timeSeries' pbjects.

Arguments

`object`	an object of class `timeSeries`.

Value

Prints an object of class `timeSeries`.

Examples

```
## Load Micsrosoft Data -
   setRmetricsOptions(myFinCenter = "GMT")
   LPP <- MSFT[1:12, 1:4]

## Abbreviate Column Names -
   colnames(LPP) <- abbreviate(colnames(LPP), 6)

## Print Data Set -
   print(LPP)

## Alternative Use, Show Data Set -
   show(LPP)
```

rank *Sample Ranks of a Time Series*

Description

Returns the sample ranks of the values of a 'timeSeries' object.

Usage

```
    ## S4 method for signature 'timeSeries'
rank(x, na.last = TRUE, ties.method = )
```

Arguments

x	an univariate object of class timeSeries.
na.last	for controlling the treatment of NAs. If TRUE, missing values in the data are put last; if FALSE, they are put first; if NA, they are removed; if "keep" they are kept with rank NA.
ties.method	a character string specifying how ties are treated; can be abbreviated.

Details

If all components are different (and no NAs), the ranks are well defined, with values in seq_len(x). With some values equal (called ???ties???), the argument ties.method determines the result at the corresponding indices. The "first" method results in a permutation with increasing values at each index set of ties. The "random" method puts these in random order whereas the default, "average", replaces them by their mean, and "max" and "min" replaces them by their maximum and minimum respectively, the latter being the typical sports ranking.

NA values are never considered to be equal: for na.last = TRUE and na.last = FALSE they are given distinct ranks in the order in which they occur in x.

Value

returns the ranks of a timeSeries object.

Examples

```
## Load Microsoft Data -
   X <- 100 * returns(MSFT)

## Compute the Ranks -
   head(rank(X[, "Open"]), 10)

## Only Interested in the Vector, then use -
   head(rank(series(X[, "Open"])), 10)
```

`readSeries` *Reads a 'timeSeries' from a File*

Description

Reads a file in table format and creates a `timeSeries` object from it.

Usage

```
readSeries(file, header = TRUE, sep = ";", zone = "",
    FinCenter = "", format, ...)
```

Arguments

`file`	the filename of a spreadsheet data set from which to import the data records.
`FinCenter`	a character with the the location of the financial center named as "continent/city".
`header`	a logical value indicating whether the file contains the names of the variables as its first line. If missing, the value is determined from the file format: 'header' is set to 'TRUE' if and only if the first row contains one fewer field than the number of columns.
`format`	a character string with the format in POSIX notation specifying the timestamp format. Note, the format has not to be specified if the first column in the file has the timestamp format specifyer, e.g. "%Y-%m-%d" for the short ISO 8601 format.
`sep`	the field seperator used in the spreadsheet file to separate columns. By default ";". Note, if `sep=";"` is specified, and reading the series fails, then the reading is automatically repeated with `sep=","`.
`zone`	the time zone or financial center where the data were recorded. By default `zone=""` which is short for GMT.
`...`	Additional arguments passed to `read.table()` function which is used to read the file.

Details

The first column of the table must hold the timestamps. Format of the stimestamps can be either specified in the header of the first column or by the `format` argument.

Value

Returns a S4 object of class `timeSeries`.

returns *Financial Returns*

Description

Compute financial returns from prices or indexes.

Usage

```
returns(x, ...)
returns0(x, ...)

## S4 method for signature 'ANY'
returns(x, method = c("continuous", "discrete",
    "compound", "simple"), percentage = FALSE, ...)
## S4 method for signature 'timeSeries'
returns(x, method = c("continuous", "discrete",
    "compound", "simple"), percentage = FALSE, na.rm = TRUE,
    trim = TRUE, ...)

getReturns(...)
returnSeries(...)
```

Arguments

x	an object of class timeSeries.
percentage	a logical value. By default FALSE, if TRUE the series will be expressed in percentage changes.
method	a character string. Which method should be used to compute the returns, "continuous", "discrete", or "compound", "simple". The second pair of methods is a synonyme for the first two methods.
na.rm	a logical value. Should NAs be removed? By Default TRUE.
trim	a logical value. Should the time series be trimmed? By Default TRUE.
...	arguments to be passed.

Value

all functions return an object of class timeSeries.

returns0 returns am untrimmed series with the first row of returns set to zero(s).

Note

The functions returnSeries, getReturns, are synonymes for the function returns. We do not recommend to use these functions.

Examples

```
## Load Microsoft Data -
   setRmetricsOptions(myFinCenter = "GMT")
   data(MSFT)
   X = MSFT[1:10, 1:4]
   X

## Continuous Returns -
   returns(X)
   returns0(X)

## Discrete Returns:
   returns(X, method = "discrete")

## Don't trim:
   returns(X, trim = FALSE)

## Use Percentage Values:
   returns(X, percentage = TRUE, trim = FALSE)
```

---

rev *Reversion of a 'timeSeries'*

Description

Reverses an uni- or multivariate 'timeSeries' object by reversing the order of the time stamps.

Usage

```
## S4 method for signature 'timeSeries'
rev(x)
```

Arguments

x	an uni- or multivariate 'timeSeries' object.

Value

Returns a reversed 'timeSeries' object.

Examples

```
## Create Dummy timeSeries -
   tS <- dummySeries()

## Reverse Series -
   rev(tS)
```

rollMean *Rolling Statistics*

Description

Computes rolling mean, min, max and median for a 'timeSeries' object.

Usage

```
rollStats(x, k, FUN=mean, na.pad=FALSE,
    align=c("center", "left", "right"), ...)

rollMean(x, k, na.pad = FALSE,
    align = c("center", "left", "right"), ...)
rollMin(x, k, na.pad = FALSE,
    align = c("center", "left", "right"), ...)
rollMax(x, k, na.pad = FALSE,
    align = c("center", "left", "right"), ...)
rollMedian(x, k, na.pad = FALSE,
    align = c("center", "left", "right"), ...)
```

Arguments

x	an uni- or multivariate 'timeSeries' object.
k	an integer width of the rolling window. Must be odd for rollMedian.
FUN	the function to be rolled.
na.pad	a logical flag. Should NA padding be added at beginning? By default FALSE.
align	a character string specifying whether the index of the result should be left- or right-aligned or centered compared to the rolling window of observations. The default choice is set to align="center".
...	optional arguments to be passed.

Details

The code in the core of the functions rollMean, rollMin, rollMax, and rollMedian was borrowed from the package zoo authored by Achim Zeileis, Gabor Grothendieck and Felix Andrews.

Value

returns an object of class 'timeSeries'.

Author(s)

Achim Zeileis, Gabor Grothendieck and Felix Andrews for code from the contributed R package zoo used in the functions rollMean, rollMin, rollMax, and rollMedian.

Examples

```
## Use Swiss Pension Fund Data Set of Returns -
   head(LPP2005REC)
   SPI <- LPP2005REC[, "SPI"]
   head(SPI)

## Plot Drawdowns -
   rmean <- rollMean(SPI, k = 10)
   plot(rmean)
```

---

rowCum *Cumulated Column Statistics*

Description

Compute cumulative row Statistics.

Usage

```
## S4 method for signature 'ANY'
rowCumsums(x, na.rm = FALSE, ...)
## S4 method for signature 'timeSeries'
rowCumsums(x, na.rm = FALSE, ...)
```

Arguments

na.rm	a logical. Should missing values be removed?
x	a time series, may be an object of class "matrix" or "timeSeries".
...	arguments to be passed.

Value

all functions return an S4 object of class timeSeries.

Examples

```
## Simulated Monthly Return Data -
   X = matrix(rnorm(24), ncol = 2)

## Compute cumulated Sums -
   rowCumsums(X)
```

runlengths *Runlengths of a Time Series*

Description

Computes runlengths of an univariate 'timeSeries' object.

Usage

```
runlengths(x, ...)
```

Arguments

x	an univariate time series of class 'timeSeries'.
...	arguments to be passed.

Value

returns an object of class `timeSeries`.

Examples

```
## random time series -
   set.seed(4711)
   x <- rnorm(12)
   tS <- timeSeries(data=x, charvec=timeCalendar(), units="x")
   tS

## return runlengths -
   runlengths(tS)
```

sample *sample*

Description

Takes a sample of the specified size from the elements of a 'timeSeries.

Value

Returns a resampled 'timeSeries' object.

Examples

```
## Monthly Calendar Series -
   x <- daily2monthly(LPP2005REC[, 1:2])[3:14, ]

## Resample the Series with respect to the time stamps -
   resampled <- sample(x)
   resampled
   is.unsorted(resampled)
```

`scale` *scale*

Description

Scales a 'timeSeries' object.

Details

`scale` is a function to center and/or scale the columns of a 'timeSeries' object.

The value of `center` determines how column centering is performed. If `center` is a numeric vector with length equal to the number of columns of `x`, then each column of `x` has the corresponding value from `center` subtracted from it. If `center` is TRUE then centering is done by subtracting the column means (omitting NAs) of `x` from their corresponding columns, and if `center` is FALSE, no centering is done.

The value of `scale` determines how column scaling is performed (after centering). If `scale` is a numeric vector with length equal to the number of columns of `x`, then each column of `x` is divided by the corresponding value from `scale`. If `scale` is TRUE then scaling is done by dividing the (centered) columns of `x` by their standard deviations if `center` is TRUE, and the root mean square otherwise. If `scale` is FALSE, no scaling is done.

Value

Returns a centered and/or scaled 'timeSeries' object.

Examples

```
## Load Series:
   x <- 100* LPP2005REC[, c("SBI", "SPI")]

## Scale and Center -
   X <- scale(x)
   hist(X[, 1], prob=TRUE)
   s <- seq(-3, 3, length=201)
   lines(s, dnorm(s), col="red")
```

series-methods *Get and Set Data of a 'timeSeries'*

Description

series returns the @.Data slot of a timeSeries object in matrix form. New series can also be assign to an already existing timeSeries.

coredata is a synonyme function nameing for series.

Usage

```
series(x)
series(x) <- value
```

Arguments

x	a timeSeries object.
value	a vector, a data.frame or a matrix object of numeric data.

See Also

timeSeries()

Examples

```
## A Dummy timeSeries Object
   ts <- timeSeries()
   ts

## Get the Matrix Part -
   mat <- series(ts)
   class(mat)
   mat

## Assign a New Univariate Series -
   series(ts) <- rnorm(12)
   ts

## Assign a New Bivariate Series -
   series(ts) <- rnorm(12)
   ts
```

smooth *Smoothes Time Series Objects*

Description

Smoothes a 'timeSeries' object.

Usage

```
smoothLowess(x, f = 0.5, ...)
smoothSpline(x, spar = NULL, ...)
smoothSupsmu(x, bass = 5, ...)
```

Arguments

x	an univariate 'timeSeries' object.
f	the lowess smoother span. This gives the proportion of points in the plot which influence the smooth at each value. Larger values give more smoothness.
spar	smoothing parameter, typically (but not necessarily) in (0,1]. By default NULL, i.e. the value will be automatically selected.
bass	controls the smoothness of the fitted curve. Values of up to 10 indicate increasing smoothness.
...	optional arguments to be passed to the underlying smoothers.

Details

The functions smoothLowess, smoothSpline, smoothSupsmu allow to smooth timeSerie object. The are interfaces to the function lowess, supmsu. and smooth.spline in R's stats package.

The ... arguments allow to pass optional arguments to the underlying stats functions and tailor the smoothing process. We refer to the manual pages of these functions for a proper setting of these options.

Value

returns a bivariate 'timeSeries' object, the first column holds the original time series data, the second the smoothed series.

Author(s)

The R core team for the underlying smoother functions.

Examples

```
## Use Close from MSFT's Price Series  -
   head(MSFT)
   MSFT.CLOSE <- MSFT[, "Close"]
   head(MSFT.CLOSE)

## Plot Original and Smoothed Series by Lowess -
   MSFT.LOWESS <- smoothLowess(MSFT.CLOSE, f = 0.1)
   head(MSFT.LOWESS)
   plot(MSFT.LOWESS)
   title(main = "Close - Lowess Smoothed")

## Plot Original and Smoothed Series by Splines -
   MSFT.SPLINE <- smoothSpline(MSFT.CLOSE, spar = 0.4)
   head(MSFT.SPLINE)
   plot(MSFT.SPLINE)
   title(main = "Close - Spline Smoothed")

## Plot Original and Smoothed Series by Supsmu -
   MSFT.SUPSMU <- smoothSupsmu(MSFT.CLOSE)
   head(MSFT.SUPSMU)
   plot(MSFT.SUPSMU)
   title(main = "Close - Spline Smoothed")
```

`sort` *Sorting a 'timeSeries' by Time Stamps*

Description

Sorts a 'timeSeries' object with respect to its time stamps.

Usage

```
## S4 method for signature 'timeSeries'
sort(x, decreasing = FALSE, ...)
```

Arguments

`x`	an uni- or multivariate `timeSeries` object.
`decreasing`	a logical flag. Should we sort in increasing or decreasing order? By default FALSE.
`...`	optional arguments passed to other methods.

Details

Sorts a time series either in increasing or decreasing time stamp order. Internally the function `order` from R's base packahe is used. `order` generates a permutation which rearranges the time stamps in ascending or descending order.

To find out if the series is unsorted, the function `is.unsorted` from R's base package can be called.

Value

Returns a sorted 'timeSeries' object, which can be increasing or decreasing in time.

Examples

```
## Monthly Calendar Series -
   x <- daily2monthly(LPP2005REC[, 1:2])[3:14, ]

## Resample the Series with respect to the time stamps -
   resampled <- sample(x)
   resampled
   is.unsorted(resampled)

## Now sort the serie in decreasing time order -
   sorted <- sort(resampled, , decreasing = TRUE)
   sorted
   is.unsorted(sorted)

## Is the reverted series ordered? -
   reverted <- rev(sorted)
   reverted
   is.unsorted(reverted)
```

SpecialDailySeries *Special Daily Time Series*

Description

Special daily 'timeSeries' functions.

Usage

```
dummyDailySeries(x = rnorm(365), units = NULL, zone = "",
    FinCenter = "")
alignDailySeries(x, method = c("before", "after", "interp", "fillNA",
    "fmm", "periodic", "natural", "monoH.FC"),
    include.weekends = FALSE, units = NULL, zone = "",
    FinCenter = "", ...)
rollDailySeries(x, period = "7d", FUN, ...)
```

Arguments

FinCenter	a character with the the location of the financial center named as "continent/city".
FUN	the function to be applied. [applySeries] - a function to use for aggregation, by default colAvgs.
include.weekends	[alignDailySeries] - a logical value. Should weekend dates be included or removed from the series.
method	[alignDailySeries] - the method to be used for the alignment. A character string, one of "before", use the data from the row whose position is just before the unmatched position, or "after", use the data from the row whose position is just after the unmatched position, or "linear", interpolate linearly between "before" and "after".
period	[rollDailySeries] - a character string specifying the rollling period composed by the length of the period and its unit, e.g. "7d" represents one week.
units	[allignDailySeries] - an optional character string, which allows to overwrite the current column names of a timeSeries object. By default NULL which means that the column names are selected automatically.
x	an object of class timeSeries.
zone	the time zone or financial center where the data were recorded.
...	arguments passed to interpolating methods.

Details

dummyDailySeries	Creates a dummy daily 'timeSeries' object,
alignDailySeries	Aligns a daily 'timeSeries' to new positions,
rollDailySeries	Rolls daily a 'timeSeries' on a given period,
ohlcDailyPlot	Plots open high low close bar chart,
dummySeries	Creates a dummy monthly 'timeSeries' object

Value

dummyDailySeries
creates from a numeric matrix with daily records of unknown dates a timeSeries object with dummy daily dates.

alignDailySeries
returns from a daily time series with missing holidays a weekly aligned daily timeSeries object

rollDailySeries

returns an object of class `timeSeries` with rolling values, computed from the function `FUN`.

Examples

```
## Use Microsofts' OHLCV Price Series -
   head(MSFT)
   end(MSFT)

## Cut out April Data from 2001 -
   Close <- MSFT[, "Close"]
   tsApril01 <- window(Close, start="2001-04-01", end="2001-04-30")
   tsApril01

## Align Daily Series with NA -
   tsRet <- returns(tsApril01, trim = TRUE)
   GoodFriday(2001)
   EasterMonday(2001)
   alignDailySeries(tsRet, method = "fillNA", include.weekends = FALSE)
   alignDailySeries(tsRet, method = "fillNA", include.weekends = TRUE)

## Align Daily Series by Interpolated Values -
   alignDailySeries(tsRet, method = "interp", include.weekend = FALSE)
   alignDailySeries(tsRet, method = "interp", include.weekend = TRUE)
```

`splits` *splits*

Description

Searches for outlier splits in a 'timeSeries' object.

Usage

```
splits(x, sd = 3, complement = TRUE, ...)
```

Arguments

`x`	a 'timeSeries' object.
`sd`	a numeric value of standard deviations, e.g. 5 means that values larger or smaller than five times the standard deviation of the series will be detected.
`complement`	a logical flag, should the outlier series or its complements be returned?
`...`	arguments to be passed.

Details

This function is thought to find splits in financial price or index series If a price or index is splitted we observe in the returns a big jump of several standard deviations which is identified usual as an outlier.

Examples

```
## Create a Return Series with a Split -
   data <- runif(12, -1, 1)
   data[6] <- 20
   x <- timeSeries(data, timeCalendar(), units="RUNIF")
   x

## Search for the Split:
   splits(x, sd=3, complement=TRUE)
   splits(x, sd=3, complement=FALSE)
```

---

spreads *Spreads and Mid Quotes*

Description

Compute spreads and midquotes from price streams.

Usage

```
spreads(x, which = c("Bid", "Ask"), tickSize = NULL)
midquotes(x, which = c("Bid", "Ask"))

midquoteSeries(...)
spreadSeries(...)
```

Arguments

tickSize	the default is NULL to simply compute price changes in original price levels. If ticksize is supplied, the price changes will be divided by the value of inTicksOfSize to compute price changes in ticks.
which	a vector with two character strings naming the column names of the time series from which to compute the mid quotes and spreads. By default these are bid and ask prices with column names c("Bid","Ask").
x	an object of class timeSeries.
...	arguments to be passed.

Value

all functions return an object of class timeSeries.

Note

The functions returnSeries, getReturns, midquoteSeries, spreadSeries are synonymes for returns, midquotes, and spreads.

Examples

```
## Load the Microsoft Data -
   setRmetricsOptions(myFinCenter = "GMT")
   data(MSFT)
   X = MSFT[1:10, ]
   head(X)

## Compute Open/Close Midquotes -
   X.MID <- midquotes(X, which = c("Close", "Open"))
   colnames(X.MID) <- "X.MID"
   X.MID

## Compute Open/Close Spreads -
   X.SPREAD <- spreads(X, which = c("Close", "Open"))
   colnames(X.SPREAD) <- "X.SPREAD"
   X.SPREAD
```

---

start *Start and End of a 'timeSeries'*

Description

Returns start and/or end time stamps of a 'timeSeries' object.

Usage

```
## S4 method for signature 'timeSeries'
start(x, ...)

## S4 method for signature 'timeSeries'
end(x, ...)
```

Arguments

x	an uni- or multivariate `timeSeries` object.
...	optional arguments passed to other methods.

Value

returns a `timeSeries` object.

Examples

```
## Create Dummy timeSeries -
   tS <- dummySeries()[, 1]
   tS
```

```
## Return Start and end Time Stamp -
   c(start(tS), end(tS))
   range(time(tS))
```

`str-methods` *timeSeries Object Structure*

Description

Compactly display the structure of a 'timeSeries' Object.

Usage

```
## S4 method for signature 'timeSeries'
str(object, ...)
```

Arguments

`object`	an object of class `timeSeries`.
`...`	arguments passed to other methods.

Value

returns a str report for an object of class `timeSeries`.

Examples

```
## Load Microsoft Data Set -
   data(MSFT)
   X <- MSFT[1:12, 1:4]
   colnames(X) <- abbreviate(colnames(X), 4)

## Display Structure -
   str(X)
```

`t` *timeSeries Transpose*

Description

Returns the transpose of a 'timeSeries' object.

Usage

```
## S4 method for signature 'timeSeries'
t(x)
```

Arguments

x	a 'timeSeries' object.

Value

Returns a matrix object.

Examples

```
## Dummy timeSeries with NAs entries
   data <- matrix(1:24, ncol = 2)
   s <- timeSeries(data, timeCalendar())
   s

## Transpose 'timeSeries' -
   t(s)
```

---

time *Get and Set Time stamps of a 'timeSeries'*

Description

Functions and methods extracting and modifying positions of 'timeSeries' objects.

Usage

```
getTime(x)
setTime(x) <- value

## S4 method for signature 'timeSeries'
time(x, ...)
## S3 replacement method for class 'timeSeries'
time(x) <- value
```

Arguments

value	a valid value for the component of time(x).
x	an object of class timeSeries.
...	optional arguments passed to other methods.

Value

Returns a 'timeDate' object.

Examples

```
## Create Dummy timeSeries -
   X <- timeSeries(matrix(rnorm(24), 12), timeCalendar())

## Return Series Positions -
   getTime(X)
   time(X)

## Add / Subtract one Day from X
   setTime(X) <- time(X) - 24*3600 # sec
   X
   time(X) <- time(X) + 24*3600 # sec
   X
```

`timeSeries-deprecated` *Deprecated functions in timeSeries package*

Description

`seriesPositions`	Extracts positions slot from a 'timeSeries',
`newPositions<-`	Modifies positions of a 'timeSeries' object,

`timeSeries-method-stats`
Time Series Correlations

Description

S4 methods of stats package for `timeSeries` objects.

`cov`	Computes Covariance from a 'timeSeries' object,
`cor`	Computes Correlations from a 'timeSeries' object.
`dcauchy`	...
`dnorm`	...
`dt`	...

Usage

```
## S4 method for signature 'timeSeries'
cov(x, y = NULL, use = "all.obs",
    method = c("pearson", "kendall", "spearman"))

## S4 method for signature 'timeSeries'
cor(x, y = NULL, use = "all.obs",
    method = c("pearson", "kendall", "spearman"))
```

Arguments

method	a character string indicating which correlation coefficient (or covariance) is to be computed. One of "pearson" (default), "kendall", or "spearman", can be abbreviated.
use	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 "all.obs", "complete.obs" or "pairwise.complete.obs".
x	an univariate object of class timeSeries.
y	NULL (default) or a timeSeries object with compatible dimensions to x. The default is equivalent to y = x (but more efficient).

Value

returns the covariance or correlation matrix.

Examples

```
## Load Microsoft Data Set -
   data(MSFT)
   X = MSFT[, 1:4]
   X = 100 * returns(X)

## Compute Covariance Matrix -
   cov(X[, "Open"], X[, "Close"])
   cov(X)
```

TimeSeriesClass *timeSeries Class*

Description

Functions to generate and modify 'timeSeries' objects:

timeSeries	Creates a 'timeSeries' object from scratch.

Data Slot and classification of 'timeSeries' objects:

seriesData Extracts data slot from a 'timeSeries'.

Usage

```
timeSeries(data, charvec, units = NULL, format = NULL, zone = "",
    FinCenter = "", recordIDs = data.frame(), title = NULL,
    documentation = NULL, ...)

seriesData(object)
```

Arguments

charvec	a character vector of dates and times or any objects which can be coerced to a timeDate object.
data	a matrix object or any objects which can be coereced to a matrix.
documentation	optional documentation string, or a vector of character strings.
FinCenter	a character with the the location of the financial center named as "continent/city".
format	the format specification of the input character vector, [as.timeSeries] - a character string with the format in POSIX notation to be passed to the time series object.
object	[is][seriesData][seriesPositions][show][summary] - an object of class timeSeries.
recordIDs	a data frame which can be used for record identification information. [print] - a logical value. Should the recordIDs printed together with the data matrix and time series positions?
title	an optional title string, if not specified the inputs data name is deparsed.
units	an optional character string, which allows to overwrite the current column names of a timeSeries object. By default NULL which means that the column names are selected automatically.
zone	the time zone or financial center where the data were recorded.
...	arguments passed to other methods.

Details

Generation of Time Series Objects:

We have defined a timeSeries class which is in many aspects similar to the S-Plus class with the same name, but has also some important differences. The class has seven Slots, the 'Data' slot which holds the time series data in matrix form, the 'position' slot which holds the time/date as a character vector, the 'format' and 'FinCenter' slots which are the same as for the 'timeDate' object, the 'units' slot which holds the column names of the data matrix, and a 'title' and a 'documentation' slot which hold descriptive character strings. Date and time is managed in the same way as for timeDate objects.

Value

`timeSeries`
returns a S4 object of class `timeSeries`.

`seriesData`

extracts the `@.Data` slot from a `timeSeries` object and is equivalent to `as.amtrix`.

Note

These functions were written for Rmetrics users using R and Rmetrics under Microsoft's Windows operating system where timze zones, daylight saving times and holiday calendars are insuffeciently supported.

Examples

```
## Load Microsoft Data -
   # Microsoft Data:
   setRmetricsOptions(myFinCenter = "GMT")
   data(MSFT)
   head(MSFT)

## Create a timeSeries Object, The Direct Way ...
   Close <- MSFT[, 5]
   head(Close)

## Create a timeSeries Object from Scratch -
   data <- as.matrix(MSFT[, 4])
   charvec <- rownames(MSFT)
   Close <- timeSeries(data, charvec, units = "Close")
   head(Close)
   c(start(Close), end(Close))

## Cut out April Data from 2001 -
   tsApril01 <- window(Close, "2001-04-01", "2001-04-30")
   tsApril01

## Compute Continuous Returns -
   returns(tsApril01)

## Compute Discrete Returns -
   returns(tsApril01, type = "discrete")

## Compute Discrete Returns, Don't trim -
   returns(tsApril01, trim = FALSE)

## Compute Discrete Returns, Use Percentage Values -
   tsRet <- returns(tsApril01, percentage = TRUE, trim = FALSE)
   tsRet

## Aggregate Weekly -
```

```
   GoodFriday(2001)
   to <- timeSequence(from = "2001-04-11", length.out = 3, by = "week")
   from <- to - 6*24*3600
   from
   to
   applySeries(tsRet, from, to, FUN = sum)

## Create large timeSeries objects with different 'charvec' object classes -
   # charvec is a 'timeDate' object
   head(timeSeries(1:1e6L, timeSequence(length.out = 1e6L, by = "sec")))
   head(timeSeries(1:1e6L, seq(Sys.timeDate(), length.out = 1e6L, by = "sec")))
   # 'charvec' is a 'POSIXt' object
   head(timeSeries(1:1e6L, seq(Sys.time(), length.out = 1e6L, by = "sec")))
   # 'charvec' is a 'numeric' object
   head(timeSeries(1:1e6L, 1:1e6L))
```

`TimeSeriesData` *Time Series Data Sets*

Description

Three data sets used in example files.

The data sets are:

`LPP2005REC`	Swiss pension fund assets returns benchmark,
`MSFT`	Daily Microsoft OHLC prices and volume,
`USDCHF`	USD CHF intraday foreign exchange xchange rates.

Examples

```
## Plot LPP2005 Example Data Set -
   data(LPP2005REC)
   plot(LPP2005REC, type = "l")

## Plot MSFT Example Data Set -
   data(MSFT)
   plot(MSFT[, 1:4], type = "l")
   plot(MSFT[, 5], type = "h")

## Plot USDCHF Example Data Set -
   # plot(USDCHF)
```

`TimeSeriesSubsettings` *Subsettig Time Series*

Description

Subset a 'timeSeries' objects due to different aspects.

`[`	"[" method for a 'timeSeries' object,
`[<-`	"[<-" method to assign value for a subset of a 'timeSeries' object,
`window`	Windows a piece from a 'timeSeries' object,
`cut`	A no longer used synonyme for window,
`head`	Returns the head of a 'timeSeries' object,
`tail`	Returns the tail of a 'timeSeries' object,
`outliers`	Removes outliers from a 'timeSeries' object.

Usage

```
## S4 method for signature 'timeSeries'
window(x, start, end, ...)

## S4 method for signature 'timeSeries'
head(x, n = 6, recordIDs = FALSE, ...)
## S4 method for signature 'timeSeries'
tail(x, n = 6, recordIDs = FALSE, ...)

## S4 method for signature 'timeSeries'
outlier(x, sd = 3, complement = TRUE, ...)

## S4 method for signature 'timeSeries'
cut(x, from, to, ...)
```

Arguments

`complement`	[outlierSeries] - a logical flag, should the outler series or its complement be returns, by default `TRUE` which returns the series free of outliers.
`from, to`	starting date and end date, `to` must be after `from`.
`start, end`	starting date and end date, `end` must be after `start`.
`n`	[head][tail] - an integer specifying the number of lines to be returned. By default `n=6`.
`recordIDs`	[head][tail] - a logical value. Should the `recordIDs` returned together with the data matrix and time series positions?
`sd`	[outlierSeries] - a numeric value of standard deviations, e.g. 10 means that values larger or smaller tahn ten times the standard deviation will be removed from the series.

x	an object of class timeSeries.
...	arguments passed to other methods.

Value

All functions return an object of class 'timeSeries'.

Examples

```
## Create an Artificial timeSeries Object -
   setRmetricsOptions(myFinCenter = "GMT")
   charvec <- timeCalendar()
   set.seed(4711)
   data <- matrix(exp(cumsum(rnorm(12, sd = 0.1))))
   tS <- timeSeries(data, charvec, units = "tS")
   tS

## Subset Series by Counts "[" -
   tS[1:3, ]

## Subset the Head of the Series -
   head(tS, 6)
```

---

turns *Turning Points of a Time Series*

Description

Extracts and analyzes turn points of an univariate timeSeries object.

Usage

```
turns(x, ...)

turnsStats(x, doplot = TRUE)
```

Arguments

x	an univariate 'timeSeries' object of financial indices or prices.
...	optional arguments passed to the function na.omit.
doplot	a logical flag, should the results be plotted? By default TRUE.

Details

The function turns determines the number and the position of extrema (turning points, either peaks or pits) in a regular time series.

The function turnsStats calculates the quantity of information associated to the observations in this series, according to Kendall's information theory.

The functions are borrowed from the contributed R package pastecs and made ready for working together with univariate timeSeries objects. You need not to load the R package pastecs, the code parts we need here are builtin in the timeSeries package.

We have renamed the function turnpoints to turns to distinguish between the original function in the contributed R package pastecs and our Rmetrics function wrapper.

For further details please consult the help page from the contributed R package pastecs.

Value

turns
returns an object of class timeSeries.

turnsStats
returns an object of class turnpoints with the following entries:
data - The dataset to which the calculation is done.
n - The number of observations.
points - The value of the points in the series, after elimination of ex-aequos.
pos - The position of the points on the time scale in the series (including ex-aequos).
exaequos - Location of exaequos (1), or not (0).
nturns - Total number of tunring points in the whole time series.
firstispeak - Is the first turning point a peak (TRUE), or not (FALSE).
peaks - Logical vector. Location of the peaks in the time series without ex-aequos.
pits - Logical vector. Location of the pits in the time series without ex-aequos.
tppos - Position of the turning points in the initial series (with ex-aequos).
proba - Probability to find a turning point at this location.
info - Quantity of information associated with this point.

Author(s)

Frederic Ibanez and Philippe Grosjean for code from the contributed R package pastecs and Rmetrics for the function wrapper.

References

Ibanez, F., 1982, Sur une nouvelle application de la theorie de l'information a la description des series chronologiques planctoniques. J. Exp. Mar. Biol. Ecol., 4, 619–632

Kendall, M.G., 1976, Time Series, 2nd ed. Charles Griffin and Co, London.

Examples

```
## Load Swiss Equities Series -
   SPI.RET <- LPP2005REC[, "SPI"]
```

```
   head(SPI.RET)

## Cumulate and Smooth the Series -
   SPI <- smoothLowess(cumulated(SPI.RET), f=0.05)
   plot(SPI)

## Plot Turn Points Series -
   SPI.SMOOTH <- SPI[, 2]
   tP <- turns(SPI.SMOOTH)
   plot(tP)

## Compute Statistics -
   turnsStats(SPI.SMOOTH)
```

`units` *Get and Set Unit Names of a 'timeSeries'*

Description

Gets and sets the column names of a 'timeSeries' object. The column names are also called units or unit names.

Usage

```
getUnits(x)
setUnits(x) <- value
```

Arguments

`x`	a 'timeSeries' object.
`value`	a `vector` of unit names.

See Also

timeSeries()

Examples

```
## A Dummy timeSeries Object
   tS <- dummySeries()
   tS

## Get the Units -
   getUnits(tS)

## Assign New Units to the Series -
   setUnits(tS) <- c("A", "B")
   head(tS)
```

wealth *Conversion of an index to wealth*

Description

Converts an index series to a wealth series normalizing the starting value to one.

Usage

```
index2wealth(x)
```

Arguments

x	an object of class 'timeSeries'.

Value

returns a time series object of the same class as the input argument x normalizing the starting value to one.

Examples

```
## Load MSFT Open Prices  -
   INDEX <- MSFT[1:20, 1]
   INDEX

## Compute Wealth Normalized to 100 -
   100 * index2wealth(INDEX)
```

window *window*

Description

Extracts a part from a 'timeSeries Object

Examples

```
## Load LPP Benchmark Returns -
   x <- LPP2005REC[, 7:9]
   range(time(x))

## Extract Data for January 2006 -
   window(x, "2006-01-01", "2006-01-31")
```

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