Package ‘timeDate’

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Description The ‘timeDate’ class fulfils the conventions of the ISO 8601 standard as well as of the ANSI C and POSIX standards. Beyond these standards it provides the ”Financial Center” concept which allows to handle data records collected in different time zones and mix them up to have always the proper time stamps with respect to your personal financial center, or alternatively to the GMT reference time. It can thus also handle time stamps from historical data records from the same time zone, even if the financial centers changed day light saving times at different calendar dates.
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Description

Package of calendar, date, time tools and utilities for Rmetrics.

Overview of Topics

This help file describes the concepts and methods behind the S4 'timeDate' class used in Rmetrics for financial data and time management together with the management of public and ecclesiastical holidays.

The 'timeDate' class fulfills the conventions of the ISO 8601 standard as well as of the ANSI C and POSIX standards. Beyond these standards it provides the "Financial Center" concept which allows to handle data records collected in different time zones and mix them up to have always the proper time stamps with respect to your personal financial center, or alternatively to the GMT reference time. It can thus also handle time stamps from historical data records from the same time zone, even if the financial centers changed day light saving times at different calendar dates.

Moreover 'timeDate' is almost compatible with the 'timeDate' class in Insightful's SPlus 'timeDate' class. If you move between the two worlds of R and SPlus, you will not have to rewrite your code. This is important for business applications.

The 'timeDate' class offers not only date and time functionality but it also offers sophisticated calendar manipulations for business days, weekends, public and ecclesiastical holidays.

This help page is presented in four sections:

1. S4 'timeDate' Class and Functions
2. Operations on 'timeDate' Objects
3. Daylight Saving Time and Financial Centers
4. Holidays and Holiday Calendars
1. S4 'timeDate' Class and Generator Functions

Date and time stamps are represented by an S4 object of class 'timeDate'.

```r
definition<-
setClass("timeDate",
  representation(
    Data = "POSIXct",
    format = "character",
    FinCenter = "character"
  ))
```

They have three slots. The @Data slot holds the time stamps which are POSIXct formatted as specified in the @format slot. The time stamps are local and belong to the financial center expressed through the slot @FinCenter.

There are several possibilities to generate a 'timeDate' object. The most forward procedure is to use one of the following functions:

- `timeDate` – Creates a 'timeDate' object from scratch,
- `timeSequence` – creates a sequence of 'timeDate' objects,
- `timeCalendar` – creates a 'timeDate' object from calendar atoms,
- `Sys.timeDate` – returns the current date and time as a 'timeDate' object.

With the function `timeDate` you can create 'timeDate' objects from scratch by specifying a character vector of time stamps and a financial center which the character vector belongs to. "GMT" is used by default as the reference for all date/time operations. But you can set the variable `myFinCenter` to your local financial center reference if you want to reference dates/time to it.

Examples:

```r
# Show My local Financial Center - Note, by Default this is "GMT"
getRmetricsOptions("myFinCenter")

# Compose Character Vectors of Dates and Times:
Times <- c( "23:12:55", "10:34:02", "08:30:00", "11:18:23")
charvec = paste(Dates, Times)

# Create a 'timeDate' object
timeDate(charvec)

# Create a 'timeDate' object with my financial center set to Zurich
myFinCenter <- "Zurich"
timeDate(charvec)

# if the 'timeDate' was recorded in a different financial center, it
# will be automatically converted to your financial center,
# i.e. "Zurich".
```
timeDate(charvec, zone = "Tokyo")

# You can also convert a recorded 'timeDate' from your financial
# center "Zurich" to another one, for example "NewYork".
timeDate(charvec, FinCenter = "NewYork")

NOTE: Rmetrics has implemented an automated date/time format identifier for many common
date/time formats which tries to automatically recognise the format for the character vector of dates
and times. You can have a look at
whichFormat(charvec).

NOTE: Rmetrics always uses the midnight standard on dates and times. You can see it with
.morningStandard("2008-01-31 24:00:00")

Alternatively we can create a sequence of 'timeDate' objects with the help of the function timeSequence.
This can be done in several ways, either by specifying the range of the data through the arguments
from and to, or when from is missing, by setting the argument length.out of the desired series.
Note in the case of a monthly sequence, you have further options. For example you can generate
the series with the first or last day in each month, or use more complex rules like the last or n-th
Friday in every month.

Examples:

# Lets work in an international environment:
setRmetricsOptions(myFinCenter = "GMT")

# Your 'timeDate' is now in the Financial Center "GMT"
timeDate(charvec)

# Daily January 2008 Sequence:
timeSequence(from = "2008-01-01", to = "2008-01-31", by = "day")

# Monthly 2008 Sequence:
tS = timeSequence(from = "2008-01-01", to = "2008-12-31", by = "month")
tS

# Do you want the last Day or the last Friday in Month Data ?
timeLastDayInMonth(tS)
timeLastNdayInMonth(tS, nday = 5)

A third possibility is to create 'timeDate' objects from calendar atoms. You can specify values or
vectors of equal length of integers denoting year, month, day, hour, minute and seconds. If every
day has the same time stamp, you can just add an offset.
Examples:

```r
# Monthly calendar for Current Year
getRmetricsOptions("currentYear")
timeCalendar()

# Daily 'timeDate' for January data from Tokyo local time 16:00
timeCalendar(2008, m=1, d=1:31, h=16, zone="Tokyo", FinCenter="Zurich")

# Or add 16 hours in seconds ...
timeCalendar(2008, m=1, d=1:31, zone="Tokyo", FinCenter="Zurich") + 16*3600
```

2. Operations on 'timeDate' Objects

Many operations can be performed on 'timeDate' objects. You can add and subtract, round and truncate, subset, coerce or transform them to other objects. These are only few options among many others.

Math Operations

Math operations can add and subtract dates and times, and perform logical operations on 'timeDate' objects.

Examples:

```r
# Date and Time Now:
now = Sys.timeDate()

# One Hour Later:
now + 3600

# Which date/time is earlier or later ?
tC = timeCalendar()
tR = tC + round(3600*rnorm(12))
tR > tC
```

Lagging

You can generate suitable lagged and iterated differences:

diff.timeDate – Returns suitably lagged and iterated differences.

Examples:
Rounding and Truncating

Dates and times can be rounded or truncated. This is useful lower frequencies than seconds, for example hourly.

round – rounds objects of class 'timeDate',
trunc – truncates objects of class 'timeDate'.

Examples:

# Round the Random Time Stamps to the Nearest Hour:
tC = timeCalendar()
tR = tC + round(3600*runif(12))
tR
round(tR, "h")

# Truncate by Hour or to the Next Full Hour::
trunc(tR, "h")
trunc(tR + 3600, "h")

Subsetting

Subsetting a 'timeDate' is a very important issue in the management of dates and times. Rmetrics offers several functions which are useful in this context:

"[" – Extracts or replaces subsets from 'timeDate' objects,
window, cut – extract a piece from a 'timeDate' object,

In this context it is also important to know the start and the end time stamp together with the total number of time stamps.

start – extracts the first entry of a 'timeDate' object,
end – extracts the last entry of a 'timeDate' object,
length – returns the length of a 'timeDate' object.

Examples:
# Create Monthly Calendar for next year
tC = timeCalendar(getRmetricsOptions("currentYear") + 1)
tC

# Start, end and length of 'timeDate' objects
start(tC)
end(tC)
length(tC)

# The first Quarter - Several Alternative Solutions:
tC[1:3]
tC[-(4:length(tC))]
window(tC, start = tC[1], end = tC[3])
cut(tC, from = tC[1], to = tC[3])
tC[tC < tC[4]]

# The Quarterly Series:
tC[seq(3, 12, by = 3)]

Weekdays, weekends, business days, and holidays can be easily obtained with the following functions:

*isWeekday* – tests if a date is a weekday or not,
*isWeekend* – tests if a date is a weekend day or not,
*isBizday* – tests if a date is a business day or not,
*isHoliday* – tests if a date is a holiday day or not.

Examples:

# A 'timeDate' Sequence around Easter 2008
Easter(2008)
tS <- timeSequence(Easter(2008, -14), Easter(2008, +14))
tS

# Subset weekdays and business days:
tW <- tS[isWeekday(tS)]; tW
dayOfWeek(tW)
tB <- tS[isBizday(tS, holidayZURICH())]; tB
dayOfWeek(tB)
The functions `blockStart` and `blockEnd` gives time stamps for equally sized blocks.

`blockStart` – Creates start dates for equally sized blocks,
`blockEnd` – Creates end dates for equally sized blocks.

Examples:

```
# 'timeDate' object for the last 365 days:
tS = timeSequence(length.out = 360)
tS

# Subset Pointers for blocks of exactly 30 days:
blockStart(tS, 30)
blockEnd(tS, 30)
Sys.timeDate()
```

**Coercions and Transformations**

'timeDate' objects are not living in an isolated world. Coercions and transformations allow 'timeDate' objects to communicate with other formatted time stamps. Be aware that in most cases information can be lost if the other date.time classes do not support this functionality. There exist several methods to coerce and transform `timeDate` objects into other objects.

`as.timeDate` – Implements Use Method,
`as.timeDate.default` – default Method,
`as.timeDate.POSIXt` – returns a 'POSIX' object as 'timeDate' object,
`as.timeDate.Date` – returns a 'POSIX' object as 'timeDate' object.

`as.character.timeDate` – Returns a 'timeDate' object as 'character' string,
`as.double.timeDate` – returns a 'timeDate' object as 'numeric' object,
`as.data.frame.timeDate` – returns a 'timeDate' object as 'data.frame' object,
`as.POSIXct.timeDate` – returns a 'timeDate' object as 'POSIXct' object,
`as.POSIXlt.timeDate` – returns a 'timeDate' object as 'POSIXlt' object,
`as.Date.timeDate` – returns a 'timeDate' object as 'Date' object.

Users or maintainers of other date/time classes can add their own generic functions. For example `as.timeDate.zoo` and `as.zoo.timeDate`.

**Concatenations and Reorderings**

It might be sometimes useful to concatenate or reorder 'timeDate' objects. The generic functions to concatenate, replicate, sort, re-sample, unify and revert a 'timeDate' objects are:
c – Concatenates 'timeDate' objects,
rep – replicates a 'timeDate' object,
sort – sorts a 'timeDate' object,
sample – resamples a 'timeDate' object,
unique – makes a 'timeDate' object unique,
rev – reverts a 'timeDate' object.

NOTE: The function c of a 'timeDate' objects takes care of possible different financial centers specific to each object to be concatenated. In such cases, all time stamps will be transformed to the financial center of the first time stamp used in the concatenation:

Examples:

```r
# Concatenate the local time stamps to Zurich time ...  
ZH = timeDate("2008-01-01 15:00:00", zone = "GMT", FinCenter = "Zurich")
NY = timeDate("2008-01-01 18:00:00", zone = "GMT", FinCenter = "NewYork")
c(ZH, NY)
c(NY, ZH)
```

3. Daylight Saving Time and Financial Centers

Each financial center worldwide has a function which returns Daylight Saving Time Rules. Almost 400 prototypes are made available through the Olson time zone data base. The cities and regions can be listed using the command listFinCenter. The DST rules for specific financial center can be viewed by their name, e.g. Zurich(). Additional financial centers can be added by the user taking care of the format specification of the DST functions.

Setting Financial Centers

All time stamps are handled according to the time zone and daylight saving time rules specified by the center through the variable myFinCenter. This variable is set by default to "GMT" but can be changed to your local financial center or to any other financial center you want to use.

NOTE: By setting the financial center to a continent/city which lies outside of the time zone used by your computer does not change any time settings or environment variables used by your computer.

To change the name of a financial center from one setting to another just assign to the variable myFinCenter the desired name of the city:

Examples:
# What is my current Financial Center ?
getRmetricsOptions("myFinCenter")

# Change to Zurich:
setRmetricsOptions(myFinCenter = "Zurich")
getRmetricsOptions("myFinCenter")

From now on, all dates and times are handled within the middle European time zone and the DST rules which are valid for Zurich.

**List of Financial Centers**

There are many other financial centers supported by Rmetrics. They can be displayed by the function `listFinCenter`. You can also display partial lists with wildcards and regular expressions:

Examples:

```r
# List all supported Financial Centers Worldwide:
listFinCenter()

# List European Financial Centers:
listFinCenter("Europe/*")
```

**DST Rules**

For each financial center a function is available. It keeps the information of the time zones and the DST rules. The functions return a data.frame with 4Columns :

```
Zurich offset isdst timeZone
... 62 2008-03-30 01:00:00 7200 1 CEST
63 2008-10-26 01:00:00 3600 0 CET
...```

The first column describes when the time was changed, the second gives the offset to "GMT", the third returns the daylight savings time flag which is positive if in force, zero if not, and negative if unknown. The last column gives the name of the time zone. You can have a look at the function `Zurich()`.:

Examples:

```r
# Show the DST Rules for Zurich:
Zurich()

# List European Financial Centers:
listFinCenter("Europe/*")
```
3. Holidays and Holiday Calendars

It is non-trivial to implement function for business days, weekends and holidays. It is not difficult in an algorithmic sense, but it can become tedious to implement the rules of the calendar themselves, for example the date of Easter.

In the following section we briefly summarise the functions which can calculate dates of ecclesiastical and public holidays. With the help of these functions we can also create business and holiday calendars.

Special Dates:
The implemented functions can compute the last day in a given month and year, the dates in a month that is a n-day (e.g. n- = Sun) on or after a given date, the dates in a month that is a n-day on or before a specified date, the n-th occurrences of a n-day for a specified year/month vectors, or the last n-day for a specified year/month value or vector.

NOTE: n-days are numbered from 0 to 6 where 0 correspond to the Sunday and 6 to the Saturday.

timeFirstDayInMonth – Computes the first day in a given month and year,
timelastDayInMonth – Computes the last day in a given month and year,
timeFirstDayInQuarter – Computes the first day in a given quarter and year,
timelastDayInQuarter – Computes the last day in a given quarter and year,
timeNdayOnOrAfter – Computes date that is a "on-or-after" n-day,
timeNdayOnOrBefore – Computes date that is a "on-or-before" n-day,
timeNthNdayInMonth – Computes n-th occurrence of a n-day in year/month,
timelastNdayInMonth – Computes the last n-day in year/month.

Holidays:

Holidays may have two origins: ecclesiastical or public/federal. The ecclesiastical calendars of Christian churches are based on cycles of movable and immovable feasts. Christmas, December 25, is the principal immovable feast. Easter is the principal movable feast, and dates of most of the other movable feasts are determined with respect to Easter. However, the movable feasts of the Advent and Epiphany seasons are Sundays reckoned from Christmas and the Feast of the Epiphany, respectively.

Examples:

```r
# List Holidays available in Rmetrics
listHolidays()

# The date of Easter for the next 5 years:
currentYear <- getRmetricsOptions("currentYear")
Easter(currentYear:(currentYear+5))
```

Holiday Calendars:
holidayZURICH – Zurich Business Calendar,
holidayNYSE – NYSE Stock Exchange Holiday Calendar,
holidayZURICH – TSX Holiday Calendar.

We would like to thanks all Rmetrics users who gave us many additional information concerning
local holidays.

References

Bateman R., (2000); Time Functionality in the Standard C Library, Novell AppNotes, September
ISO-8601, (1988); Data Elements and Interchange Formats - Information Interchange, Representation
of Dates and Time, International Organization for Standardization, Reference Number ISO
8601, 14 pages.
James D.A., Pregibon D. (1992), Chronological Objects for Data Analysis, Reprint.

.endpoints

Description

Returns endpoint indexes from a ‘timeDate’ object

Usage

.endpoints(x, on = c("months", "years", "quarters", "weeks", "days",
    "hours", "minutes", "seconds"), k=1)

Arguments

x a timeDate object.
on the periods endpoints to find as a character string. Select from: "months",
    "years", "quarters", "weeks", "days", "hours", "minutes", "seconds".
k along every k-th element.

Details

endpoints returns an integer vector corresponding to the last observation in each period specified
by on, with a zero added to the beginning of the vector, and the index of the last observation in x at
the end.
Value

returns an integer vector of endpoints beginning with 0 and ending with the a value equal to the length of the x argument.

Author(s)

Jeff Ryan, modified by Diethelm Wuertz for timeDate objects.

Examples

```
## endpoints -

# Weekly Endpoints:
.endpoints(timeCalendar(), on="w")
```

Description

Aligns a 'timeDate' object to regular date/time stamps.

Usage

```
## S4 method for signature 'timeDate'
align(x, by = "1d", offset = "0s")

alignDaily(x, include.weekends=FALSE)
alignMonthly(x, include.weekends=FALSE)
alignQuarterly(x, include.weekends=FALSE)
```

Arguments

- **x**: an object of class timeDate.
- **by**: a character string formed from an integer length and a period identifier. Valid values are "w", "d", "h", "m", "s", for weeks, days, hours, minutes and seconds. For example a bi-weekly period is expressed as "2w".
- **offset**: a character string to set an offset formed from an integer length and a period identifier in the same way as for the argument by.
- **include.weekends**: logical value indicating whether 'weekends' should be included.

Details

The functions alignDaily, alignMonthly, alignMonthly are simple to use functions which generate end-of-day, end-of-month, and end-of-quarter timeDate objects. Weekends are excluded by default. Optionally they can be added setting the argument include.weekends=TRUE.
Value

returns an object of class `timeDate`.

Examples

```r
## align -
# Align Bi-Weekly with a 3 Days Offset:
(tC <- timeCalendar())
align(tC, by = "2w", offset = "3d")

## alignDaily -
# Simple to use Functions:
alignDaily(tC)
alignDaily(tC, include.weekends=TRUE)

# Align to end-of-month Dates:
alignMonthly(tC)
```

## Description

Coerce and transform objects of class ‘timeDate’.

Usage

```r
## S3 method for class 'timeDate'
as.character(x, ...)

## S3 method for class 'timeDate'
as.double(x,
    units = c("auto", "secs", "mins", "hours", "days", "weeks"), ...)

## S3 method for class 'timeDate'
as.data.frame(x, ...)

## S3 method for class 'timeDate'
as.POSIXct(x, tz = ",", ...)

## S3 method for class 'timeDate'
as.POSIXlt(x, tz = ",", ...)

## S3 method for class 'timeDate'
as.Date(x, method = c("trunc", "round", "next"), ...)
```
## Default S3 method:

```r
as.timeDate(x, zone = "", FinCenter = "")
```

## S3 method for class 'POSIXt'

```r
as.timeDate(x, zone = "", FinCenter = "")
```

## S3 method for class 'Date'

```r
as.timeDate(x, zone = "", FinCenter = "")
```

## S3 method for class 'timeDate'

```r
as.timeDate(x, zone = x@FinCenter, FinCenter = "")
```

### Arguments

- **FinCenter**
  - A character with the location of the financial center named as "continent/city".

- **method**
  - A character string denoting the method how to determine the dates.

- **tz**
  - Inputs the time zone to POSIX objects, i.e. the time zone, zone, or financial center string, FinCenter, as used by `timeDate` objects.

- **units**
  - A character string denoting the date/time units in which the results are desired.

- **x**
  - An object of class `timeDate`.

- **zone**
  - The time zone or financial center where the data were recorded.

- **...**
  - Arguments passed to other methods.

### Value

- `as.timeDate.POSIXt` returns an object of class `timeDate`.
- `as.timeDate.Date` returns an object of class `timeDate`.

### Examples

```r
## timeDate -
    tC = timeCalendar()

## Convert 'timeDate' to a character strings:
    as.character(tC)

## Coerce a 'Date' object into a 'timeDate' object:
    as.timeDate(Sys.Date())
```

### Description

Creates start (end) dates for equally sized 'timeDate' blocks.
Usage

blockStart(x, block = 20)
blockEnd(x, block = 20)

Arguments

block an integer value specifying the length in number of records for numerically sized blocks of dates.
x an object of class `timedate`.

Details

The functions blockStart and blockEnd create vectors of start and end values for equally sized 'timeDate' blocks. Note, the functions are event counters and not a time counter between measuring time intervals between start and end dates! For equally sized blocks in time one has before to align the time stamps in equal time differences.

Value

returns an object of class "timeDate".

Examples

```r
# 360 Days Series:
tS <- timeSequence(length.out = 360)

# blockStart | blockEnd -
Start <- blockStart(tS, 30)
End <- blockEnd(tS, 30)
Start
End
End-Start
```

Description

Concatenates 'timeDate' objects.

Usage

```r
## S3 method for class 'timeDate'
c(..., recursive = FALSE)
```
Arguments

recursive a logical. If recursive is set to TRUE, the function recursively descends through lists combining all their elements into a vector.

... arguments passed to other methods.

Value

returns an object of class "timeDate".

Examples

```r
## timeCalendar -
# Create Character Vectors:
GMT = timeCalendar(zone = "GMT", FinCenter = "GMT") + 16*3600
ZUR = timeCalendar(zone = "GMT", FinCenter = "Zurich") + 16*3600

## c -
# Concatenate and Replicate timeDate Objects:
sort(c(GMT, ZUR))
sort(c(ZUR, GMT))
```

## currentYear Current Year

**Description**

A variable with the current year.

**Note**

It is not allowed to change this variable.

**Examples**

```r
## currentYear -
getRmetricsOptions("currentYear")
```
Daylight Saving Time

Description

Functions for about 400 cities and regions which return daylight saving time rules and time zone offsets.

Details

As a selection of these functions:


Note

There are currently two synonyms available "Pacific" for Los Angeles and "Eastern" for New York. Specific time zones (AST, CET, CST, EET, EST, MST and PST) are also available.

Note we leave the space in all double named cities like New York or Hong Kong and use an underscore for it.

All the entries are retrieved from the tzdata library which is available under GNU GPL licence.

Examples

```r
## DST Rules for Zurich:
head(Zurich())
tail(Zurich())

## list all available centers
listFinCenter()
```
**Description**

returns the day of the year from a 'timeDate' object.

**Usage**

dayOfWeek(x)

**Arguments**

x  
an object of class timedate.

**Value**

returns a three letter character string with the names in English of the day of the week.

**Note**

With version 2.7 the function has been renamed from getdayOfWeek.

**See Also**

dayOfYear

**Examples**

```r
## timeCalendar -
tC = timeCalendar()

## The days of the Year:
dayOfWeek(tC)

## Use Deprecated Function:
getDayOfWeek <- dayOfWeek
g.getDayOfWeek(tC)
```
**dayOfYear**

**Day of the Year**

- **Description**
  
  returns the day of the year from a `timeDate` object.

- **Usage**
  
  `dayOfYear(x)`

- **Arguments**
  
  `x` an object of class `timeDate`.

- **Value**
  
  returns the day count as integer value starting January, 1st.

- **Note**
  
  With version 2.7 the function has been renamed from `getdayOfYear`.

- **See Also**
  
  `dayOfWeek`

- **Examples**

  ```r
  ## timeCalendar -
  tC = timeCalendar()
  
  ## The days of the Year:
  dayOfYear(tC)
  
  ## Use Deprecated Function:
  getDayOfYear <- dayOfYear
  getDayOfYear(tC)
  ```
Lagged 'timeDate' Differences

Description

Returns suitably lagged and iterated differences.

Usage

```r
## S3 method for class 'timeDate'
diff(x, lag = 1, differences = 1, ...)
```

Arguments

- **x**: an object of class `timeDate`.
- **lag**: an integer indicating which lag to use.
- **differences**: an integer indicating the order of the difference.
- **...**: arguments passed to other methods.

Value

For the function `diff.timeDate`, if `x` is a vector of length `n` and `differences`=1, then the computed result is equal to the successive differences `x[(1+lag):n] - x[1:(n-lag)]`. If difference is larger than one this algorithm is applied recursively to `x`. Note that the returned value is a vector which is shorter than `x`.

Examples

```r
## Create Character Vectors:
dts
tms = c( "23:12:55", "10:34:02", "08:30:00", "11:18:23")
tms

## timeDate -
GMT = timeDate(dts, zone = "GMT", FinCenter = "GMT") + 24*3600
GMT
ZUR = timeDate(dts, zone = "GMT", FinCenter = "Europe/Zurich")
ZUR

## diff -
# Suitably Lagged and Iterated Differences:
diff(GMT)
diff(GMT, lag = 2)
diff(GMT, lag = 1, diff = 2)
```
**difftimeDate**

*Difference of two 'timeDate' Objects*

**Description**

Returns a difference of two 'timeDate' objects.

**Usage**

```
difftimeDate(time1, time2, units = c("auto", "secs", "mins", "hours", "days", "weeks"))
```

**Arguments**

- `time1`, `time2`: two objects of class `timeDate`.
- `units`: a character string denoting the date/time units in which the results are desired.

**Value**

The function, `difftimeDate`, takes a difference of two `timeDate` objects and returns an object of class "difftime" with an attribute indicating the units.

**Examples**

```r
## Create Character Vectors:
  dts

## timeDate -
  GMT = timeDate(dts, zone = "GMT", FinCenter = "GMT")
  GMT

## diff -
  # Suitably Lagged and Iterated Differences:
  difftimeDate(GMT[1:2], GMT[-(1:2)])
```

---

**easter**

*Date of Easter*

**Description**

Returns the date of Easter.

**Usage**

```
easter(year = getRmetricsOptions("currentYear"), shift = 0)
```
Arguments

- **year**: an integer value or integer vector for the year(s).
- **shift**: an integer value, the number of days shifted from the Easter date. Negative integers are allowed.

Details

Holidays may have two origins, ecclesiastical and public/federal. The ecclesiastical calendars of Christian churches are based on cycles of moveable and immoveable feasts. Christmas, December 25th, is the principal immoveable feast. Easter is the principal moveable feast, and dates of most other moveable feasts are determined with respect to Easter.

The date of Easter is evaluated by a complex procedure whose detailed explanation goes beyond this description. The reason that the calculation is so complicated is, because the date of Easter is linked to (an inaccurate version of) the Hebrew calendar. But nevertheless a short answer to the question "When is Easter?" is the following: Easter Sunday is the first Sunday after the first full moon after vernal equinox. For the long answer we refer to Toendering (1998).

The algorithm computes the date of Easter based on the algorithm of Oudin (1940). It is valid for any Gregorian Calendar year.

Value

returns the date of Easter as an object of class `timeDate`.

Examples

```r
## Easter -

# Current Year:
Easter()

# From 2001 to 2010:
Easter(2001:2010)
```

**finCenter**

Financial Center of a `timeDate` object

Description

Print or assign new financial center to a `timeDate` object.

Usage

```r
## S4 method for signature 'timeDate'
finCenter(x)
## S4 replacement method for signature 'timeDate'
finCenter(x) <- value
```
Arguments

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

See Also
listFinCenter

Examples

date <- timeDate("2008-01-01")
finCenter(date) <- "GMT"
date

finCenter(date) <- "Zurich"
date

firstDay

First and Last Days

Description
Computes the first/last day in a given month/quarter.

Usage

timeFirstDayInMonth(charvec, format = "%Y-%m-%d", zone = "", FinCenter = "")
timeLastDayInMonth(charvec, format = "%Y-%m-%d", zone = "", FinCenter = "")
timeFirstDayInQuarter(charvec, format = "%Y-%m-%d", zone = "", FinCenter = "")
timeLastDayInQuarter(charvec, format = "%Y-%m-%d", zone = "", FinCenter = "")

Arguments
charvec a character vector of dates and times.
format the format specification of the input character vector.
zone the time zone or financial center where the data were recorded.
FinCenter a character with the location of the financial center named as "continent/city".
Value

returns an object of class `timeDate`.

For the functions `timeLastDayInMonth` and `timeLastDayInMonth` return the last or first day respectively in a given month and year.

The same functionality for quarterly time horizons is returned by the functions `timeLastDayInQuarter` and `timeLastDayInQuarter`.

Examples

```r
## Date as character String:
charvec = "2006-04-16"
myFinCenter = getRmetricsOptions("myFinCenter")

## timeLastDayInMonth -
# What date has the last day in a month for a given date ?
timeLastDayInMonth(charvec, format = "%Y-%m-%d",
zone = myFinCenter, FinCenter = myFinCenter)
timeLastDayInMonth(charvec)
timeLastDayInMonth(charvec, FinCenter = "Zurich")

## timeFirstDayInMonth -
# What date has the first day in a month for a given date ?
timeFirstDayInMonth(charvec)

## timeLastDayInQuarter -
# What date has the last day in a quarter for a given date ?
timeLastDayInQuarter(charvec)

## timeFirstDayInQuarter -
# What date has the first day in a quarter for a given date ?
timeFirstDayInQuarter(charvec)

## timeNdayOnOrAfter
# What date has the first Monday on or after March 15, 1986 ?
timeNdayOnOrAfter("1986-03-15", 1)

## timeNdayOnOrBefore
# What date has Friday on or before April 22, 1977 ?
timeNdayOnOrBefore("1986-03-15", 5)

## timeNthNdayInMonth -
# What date is the second Monday in April 2004 ?
timeNthNdayInMonth("2004-04-01", 1, 2)

## timeLastNdayInMonth -
# What date has the last Tuesday in May, 1996 ?
timeLastNdayInMonth("1996-05-01", 2)
```
Format Methods

Description

Formats 'timeDate' objects as ISO conform character strings.

Usage

```r
## S3 method for class 'timeDate'
format(x, format = "", tz = "", usetz = FALSE, ...)
```

Arguments

- `format`: a character string describing the format.
- `tz`: a timezone specification to be used for the conversion.
- `usetz`: a logical.
- `x`: an object of class `timeDate`.
- `...`: arguments passed to other methods.

Value

returns an ISO conform formatted character string.

Note

This S3 method will become in the future a S4 method

See Also

`as.character`

Examples

```r
## timeCalendar -
# Time Calendar 16:00
tC = timeCalendar() + 16*3600
tC

## Format as ISO Character String:
format(tC)
```
**holiday**

---

### Holiday Dates

**Description**

Returns the date of a holiday.

**Usage**

```r
holiday(year = getRmetricsOptions("currentYear"), Holiday = "Easter")
```

**Arguments**

- **Holiday**: the unquoted function name of an ecclesial or public holiday in the G7 countries or Switzerland, see the list below.
- **year**: an integer value or vector of years, formatted as YYYY.

**Details**

Easter is the central ecclesial holiday. Many other holidays are related to this feast. The function `easter` computes the dates of Easter and related ecclesial holidays for the requested year vector. The function `holiday` calculates the dates of ecclesial or public holidays in the G7 countries, e.g. `holiday(2003, "GoodFriday")`. Rmetrics contains holiday functions automatically loaded at startup time. The user can add easily additional holiday functions. The information for the holidays is collected from several web pages about holiday calendars. The following ecclesial and public holidays in the G7 countries and Switzerland are available:

**Holidays Related to Easter:**

- Septuagesima, Quinquagesima, AshWednesday, PalmSunday, GoodFriday, EasterSunday, Easter, EasterMonday, RogationSunday, Ascension, Pentecost, PentecostMonday, TrinitySunday CorpusChristi.

**Holidays Related to Christmas:**


**Other Ecclesiical Feasts:**


**CHZurich - Public Holidays:**


**GBLondon - Public Holidays:**

-
GBMayDay, GBBankHoliday, GBSummerBankHoliday, GBNewYearsEve.

**DEFrankfurt - Public Holidays:**
DEAscension, DECorpusChristi, DEGermanUnity, DEChristmasEve, DENewYearsEve.

**FRParis - Public Holidays:**
FRFetDeLaVictoire1945, FRAscension, FRBastilleDay, FRAssumptionVirginMary, FRAllSaints, FRArmisticeDay.

**ITMilano - Public Holidays:**
ITEpiphany, ITLiberationDay, ITRepublicAnniversary, ITAssumptionOfVirginMary, ITAllSaints, ITWWIVictoryAnniversary, ITStAmrose, ITImmaculateConception.

**USNewYork/USChicago - Public Holidays:**

**CAToronto/CA Montreal - Public Holidays:**

**JPTokyo/JPOsaka - Public Holidays:**

**Value**
The function `holiday` returns an object of class `timeDate`.

**Examples**

```r
## holiday -
# Dates for GoodFriday from 2000 until 2010:
holiday(2000:2010, "GoodFriday")

## Easter -
```
### GoodFriday -
- GoodFriday(2000:2010)

---

**holidayDate**

**Public and Ecclesiastical Holidays**

---

**Description**

A collection and description of functions and methods dealing with holiday dates in the G7 countries and Switzerland.

**Usage**

```r
Septuagesima(year = getRmetricsOptions("currentYear"))
Quinquagesima(year = getRmetricsOptions("currentYear"))
AshWednesday(year = getRmetricsOptions("currentYear"))
PalmSunday(year = getRmetricsOptions("currentYear"))
GoodFriday(year = getRmetricsOptions("currentYear"))
EasterSunday(year = getRmetricsOptions("currentYear"))
EasterMonday(year = getRmetricsOptions("currentYear"))
RogationSunday(year = getRmetricsOptions("currentYear"))
Ascension(year = getRmetricsOptions("currentYear"))
Pentecost(year = getRmetricsOptions("currentYear"))
PentecostMonday(year = getRmetricsOptions("currentYear"))
TrinitySunday(year = getRmetricsOptions("currentYear"))
CorpusChristi(year = getRmetricsOptions("currentYear"))
ChristTheKing(year = getRmetricsOptions("currentYear"))
Advent1st(year = getRmetricsOptions("currentYear"))
Advent2nd(year = getRmetricsOptions("currentYear"))
Advent3rd(year = getRmetricsOptions("currentYear"))
Advent4th(year = getRmetricsOptions("currentYear"))
ChristmasEve(year = getRmetricsOptions("currentYear"))
ChristmasDay(year = getRmetricsOptions("currentYear"))
BoxingDay(year = getRmetricsOptions("currentYear"))
NewYearsDay(year = getRmetricsOptions("currentYear"))
SolemnityOfMary(year = getRmetricsOptions("currentYear"))
Epiphany(year = getRmetricsOptions("currentYear"))
PresentationOfLord(year = getRmetricsOptions("currentYear"))
Annunciation(year = getRmetricsOptions("currentYear"))
TransfigurationOfLord(year = getRmetricsOptions("currentYear"))
AssumptionOfMary(year = getRmetricsOptions("currentYear"))
BirthOfVirginMary(year = getRmetricsOptions("currentYear"))
CelebrationOfHolyCross(year = getRmetricsOptions("currentYear"))
MassOfArchangels(year = getRmetricsOptions("currentYear"))
AllSaints(year = getRmetricsOptions("currentYear"))
```

Holiday

```
getAllSens(year = getRmetricsOptions("currentYear"))
LaborDay(year = getRmetricsOptions("currentYear"))
CHberchtoldsDay(year = getRmetricsOptions("currentYear"))
CHSechseleaeuten(year = getRmetricsOptions("currentYear"))
CHAscension(year = getRmetricsOptions("currentYear"))
CHConfederationDay(year = getRmetricsOptions("currentYear"))
CHKnabenschiessen(year = getRmetricsOptions("currentYear"))
GBMayDay(year = getRmetricsOptions("currentYear"))
GBBankHoliday(year = getRmetricsOptions("currentYear"))) # see note in details section
GBSummerBankHoliday(year = getRmetricsOptions("currentYear")))
GBMillenniumDay(year = getRmetricsOptions("currentYear")))
DEAscension(year = getRmetricsOptions("currentYear")))
DECorpusChristi(year = getRmetricsOptions("currentYear")))
DEGermanUnity(year = getRmetricsOptions("currentYear")))
DEChristmasEve(year = getRmetricsOptions("currentYear")))
DENewYearsEve(year = getRmetricsOptions("currentYear")))
FRFetDelavictoire1945(year = getRmetricsOptions("currentYear")))
FRAscension(year = getRmetricsOptions("currentYear")))
FRBastilleDay(year = getRmetricsOptions("currentYear")))
FRAssumptionVirginMary(year = getRmetricsOptions("currentYear")))
FRAllSaints(year = getRmetricsOptions("currentYear")))
FRArmisticeDay(year = getRmetricsOptions("currentYear")))
ITEpiphany(year = getRmetricsOptions("currentYear")))
ITLiberationDay(year = getRmetricsOptions("currentYear")))
ITAssumptionOfVirginMary(year = getRmetricsOptions("currentYear")))
ITAllSaints(year = getRmetricsOptions("currentYear")))
ITStAmrose(year = getRmetricsOptions("currentYear")))
ITImmaculateConception(year = getRmetricsOptions("currentYear")))
USDecorationMemorialDay(year = getRmetricsOptions("currentYear")))
USPresidentsDay(year = getRmetricsOptions("currentYear")))
USNewYearsDay(year = getRmetricsOptions("currentYear")))
USInaugurationDay(year = getRmetricsOptions("currentYear")))
USMLKingsBirthday(year = getRmetricsOptions("currentYear")))
USLincolnsBirthday(year = getRmetricsOptions("currentYear")))
USWashingtonsBirthday(year = getRmetricsOptions("currentYear")))
USMemorialDay(year = getRmetricsOptions("currentYear")))
USIndependenceDay(year = getRmetricsOptions("currentYear")))
USLaborDay(year = getRmetricsOptions("currentYear")))
USColumbusDay(year = getRmetricsOptions("currentYear")))
USElectionDay(year = getRmetricsOptions("currentYear")))
USVeteransDay(year = getRmetricsOptions("currentYear")))
USThanksgivingDay(year = getRmetricsOptions("currentYear")))
USChristmasDay(year = getRmetricsOptions("currentYear")))
USCulskiBirthday(year = getRmetricsOptions("currentYear")))
USGoodFriday(year = getRmetricsOptions("currentYear")))
CAVictoriaDay(year = getRmetricsOptions("currentYear")))
CACanadaDay(year = getRmetricsOptions("currentYear")))
CACivicProvincialHoliday(year = getRmetricsOptions("currentYear")))
```
CALabourDay(year = getRmetricsOptions("currentYear"))
CATHanksgivingDay(year = getRmetricsOptions("currentYear"))
CarMembranceDay(year = getRmetricsOptions("currentYear"))
JPVernalEquinox(year = getRmetricsOptions("currentYear"))
JPNYNewYearsDay(year = getRmetricsOptions("currentYear"))
JPGantan(year = getRmetricsOptions("currentYear"))
JPBnBankHolidayJan2(year = getRmetricsOptions("currentYear"))
JPBnBankHolidayJan3(year = getRmetricsOptions("currentYear"))
JPCongingOfAgeDay(year = getRmetricsOptions("currentYear"))
JPSeijinNoHi(year = getRmetricsOptions("currentYear"))
JPNatFoundationDay(year = getRmetricsOptions("currentYear"))
JPKenKokuKinenNoHi(year = getRmetricsOptions("currentYear"))
JPGreeneryDay(year = getRmetricsOptions("currentYear"))
JPMidoriNoHi(year = getRmetricsOptions("currentYear"))
JPConstitutionDay(year = getRmetricsOptions("currentYear"))
JPKenKouKinenBi(year = getRmetricsOptions("currentYear"))
JPNatioNHoliday(year = getRmetricsOptions("currentYear"))
JKokuminNoKyuifu(year = getRmetricsOptions("currentYear"))
JPCChildrensDay(year = getRmetricsOptions("currentYear"))
JKoDomoNoHi(year = getRmetricsOptions("currentYear"))
JPMarineDay(year = getRmetricsOptions("currentYear"))
JPMimiNoHi(year = getRmetricsOptions("currentYear"))
JPR espectForTheAgedDay(year = getRmetricsOptions("currentYear"))
JPKeiDouNoHi(year = getRmetricsOptions("currentYear"))
JPAutumnalEquinox(year = getRmetricsOptions("currentYear"))
JPSuubunNoHi(year = getRmetricsOptions("currentYear"))
JPHalthAndSportsDay(year = getRmetricsOptions("currentYear"))
JPTaiikuNoHi(year = getRmetricsOptions("currentYear"))
JPNationalCultureDay(year = getRmetricsOptions("currentYear"))
JPBunkaNoHi(year = getRmetricsOptions("currentYear"))
JPTennesseeDay(year = getRmetricsOptions("currentYear"))
JPKinrouKanshaNoHi(year = getRmetricsOptions("currentYear"))
JPEperorOsBirthday(year = getRmetricsOptions("currentYear"))
JPTennouTanryouBi(year = getRmetricsOptions("currentYear"))
JPBnBankHolidayDec31(year = getRmetricsOptions("currentYear"))

Arguments

year an integer value or vector of year numbers including the century. These are integers of the form CCYY, e.g. 2000.

Details

Note that GBBankHoliday() returns GB Spring bank holiday. For GB holiday calendar see holidayGB().

Value

The function listHolidays returns a character vector with the names of the supported holidays. The holiday functions return an ISO-8601 formatted 'timeDate' of the requested holiday.
Examples

```r
## listHolidays -
listHolidays()

## CHSechselaeuten -
# Sechselaeuten a half Day Bank Holiday in Switzerland
CHSechselaeuten(getRmetricsOptions("currentYear"))

## German Unification Day:  
DEGermanUnity(getRmetricsOptions("currentYear"))
```

---

**holidayLONDON**  
*London Bank Holidays*

Description

Returns bank holidays in London.

Usage

```r
holidayLONDON(year = getRmetricsOptions("currentYear"))
```

Arguments

- **year**  
an integer value or vector of years, formatted as YYYY.

Details

There are 8 bank holidays in Britain every year: New Year’s Day, Good Friday, Easter Monday, Spring (May), Last Monday of May, End of Summer (Last Monday) August, Christmas Eve, Christmas Day.

Value

returns an object of class `timeDate`.

Author(s)

Function contributed by Menon Murali

Examples

```r
## holidayLONDON -
holidayLONDON()
holidayLONDON(2008:2010)
```
**holidayNerc**

**NERC Holiday Calendar**

**Description**

Returns a holiday calendar for NERC, the North American Reliability Council.

**Usage**

```r
holidayNerc(year = getRmetricsOptions(\"currentYear\"), FinCenter = \"Eastern\")
```

**Arguments**

- `year`: an integer value or vector of years, formatted as `YYYY`.
- `FinCenter`: a character value, the name of the financial center to use.

**Value**

returns an object of class `timeDate`.

**Author(s)**

Joe W. Byers

**References**

http://www.nerc.com/~oc/offpeaks.html

**Examples**

```r
## holidayNerc
holidaysNerc()
```

---

**holidayNyse**

**NYSE Holiday Calendar**

**Description**

Returns a holiday calendar for the New York Stock Exchange.

**Usage**

```r
holidayNyse(year = getRmetricsOptions(\"currentYear\"))
```
holidayTSX

Arguments

year an integer value or vector of years, formatted as YYYY.

Value

returns an object of class timedate.

Examples

```r
## holidayNYSE -
holidayNYSE()
holidayNYSE(2008:2010)
```
Description

Returns a holiday calendar for Zurich.

Usage

```r
holidayZURICH(year = getRmetricsOptions("currentYear"))
```

Arguments

- `year` an integer value or vector of years, formatted as YYYY.

Details


Value

returns an object of class timeDate.

Examples

```r
## holidayZURICH -
holidayZURICH()
holidayZURICH(2008:2010)
```

---

is.na-methods is.na Methods

Description

is.na methods for 'timeDate' objects.
isBizday

Examples

# Create a timeCalendar sequence
(td <- timeCalendar())
is.na(td)

# insert NA's
is.na(td) <- 2:3
td

# test of NA's
is.na(td)

isBizday  Business and Holidays

Description

Tests if a date is a business day or not.

Usage

isBizday(x, holidays = holidayNYSE(), wday = 1:5)
isHoliday(x, holidays = holidayNYSE(), wday = 1:5)

Arguments

x
an object of class timeDate.

holidays
holiday dates from a holiday calendar. An object of class timeDate.

wday
Specify which days should be considered as weekdays. By default from Mondays to Fridays.

Value

a logical vector of the same length as x indicating if a date is a business day, or a holiday, respectively.

Examples

## Dates in April, currentYear:
currentYear = getRmetricsOptions("currentYear")
tS = timeSequence(
  from = paste(currentYear, "-03-01", sep = ""),
  to = paste(currentYear, "-04-30", sep = ""))
tS

## Subset Business Days at NYSE:
holidayNYSE()
isBizday(tS, holidayNYSE())
tS[isBizday(tS, holidayNYSE())]
isRegular | Checks if a date/time vector is regular

Description

Checks if a date/time vector is regular. i.e. if it is a daily, a monthly, or a quarterly date/time vector. If the date/time vector is regular the frequency can determined calling the function frequency.

Usage

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

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

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

Arguments

- `x` an R object of class `timeDate`
- `...` arguments to be passed

Details

A date/time vector is defined as daily if the vector has not more than one date/time stamp per day.
A date/time vector is defined as monthly if the vector has not more than one date/time stamp per month.
A date/time vector is defined as quarterly if the vector has not more than one date/time stamp per quarter.
A monthly date/time vector is also a daily vector, a quarterly date/time vector is also a monthly vector.
A regular date/time vector is either a monthly or a quarterly vector.
NOT yet implemented is the case of weekly vectors.

Value

The `is*` functions return TRUE or FALSE depending on whether the date/time vector fulfills the condition or not.
The function `frequency` returns in general 1, for quarterly date/time vectors 4, and for monthly vectors 12.
isWeekday

Examples

## None

---

**isWeekday**  

*Weekdays and Weekends*

**Description**

Tests if a date is a weekday or not.

**Usage**

isWeekday(x, wday = 1:5)

isWeekend(x, wday = 1:5)

**Arguments**

- **x**
  - an object of class `timeDate`.

- **wday**
  - Specify which days should be considered as weekdays. By default from Mondays to Fridays.

**Value**

the functions return logical vectors indicating if a date is a weekday, or a weekend day.

**Examples**

## Dates in April, currentYear:

```r
currentYear = getRmetricsOptions("currentYear")
tS = timeSequence(
    from = paste(currentYear, "-03-01", sep = ""),
    to = paste(currentYear, "-04-30", sep = ""))
tS
```

## Subset of Weekends:

```r
isWeekend(tS)
tS[isWeekend(tS)]
```
**Description**

Returns Julian day counts, date/time atoms from a `timeDate` object, and extracts month atoms from a `timeDate` object.

**Usage**

```r
## S4 method for signature 'timeDate'
julian(x, origin = timeDate("1970-01-01"),
       units = c("auto", "secs", "mins", "hours", "days", "weeks"),
       zone = NULL, FinCenter = NULL, ...)

## S4 method for signature 'timeDate'
atoms(x, ...)

## S4 method for signature 'timeDate'
months(x, abbreviate = NULL)
```

**Arguments**

- `x`: an object of class `timeDate`.
- `origin`: a length-one object inheriting from class "timeDate" setting the origin for the julian counter.
- `units`: a character string denoting the date/time units in which the results are desired.
- `zone`: the time zone or financial center where the data were recorded.
- `FinCenter`: a character with the the location of the financial center named as "continent/city".
- `abbreviate`: currently not used.
- `...`: arguments passed to other methods.

**Value**

- julian returns a `timeDate` object as a Julian count.
- atoms and months extract from a `timeDate` object the calendar atoms, i.e. the year, month, day, and optionally hour, minute and second.

**Examples**

```r
## julian -
tC = timeCalendar()
julian(tC)[1:3]

## atoms -
atoms(tC)
```
## kurtosis

### Description

Functions to compute kurtosis.

### Usage

```r
kurtosis(x, ...)  
## Default S3 method:  
kurtosis(x, na.rm = FALSE, method = c("excess", "moment", "fisher"), ...)  
## S3 method for class 'data.frame'  
kurtosis(x, ...)  
## S3 method for class 'POSIXct'  
kurtosis(x, ...)  
## S3 method for class 'POSIXlt'  
kurtosis(x, ...)
```

### Arguments

- `na.rm`: a logical. Should missing values be removed?
- `method`: a character string which specifies the method of computation. These are either "moment", "fisher", or "excess". If "excess" is selected, then the value of the kurtosis is computed by the "moment" method and a value of 3 will be subtracted. The "moment" method is based on the definitions of kurtosis for distributions; these forms should be used when resampling (bootstrap or jackknife). The "fisher" method correspond to the usual "unbiased" definition of sample variance, although in the case of kurtosis exact unbiasedness is not possible.
- `x`: a numeric vector or object.
- `...`: arguments to be passed.

### Value

`kurtosis` returns the value of the statistics, a numeric value. An attribute which reports the used method is added.

### See Also

- `link{skewness}`.
Examples

```r
## mean -
## var -
# Mean, Variance:
r = rnorm(100)
mean(r)
var(r)

## kurtosis -
kurtosis(r)
```

---

length

*Length of a 'timeDate' Object*

Description

Returns the length of a 'timeDate' object.

Usage

```r
## S3 method for class 'timeDate'
length(x)
```

Arguments

- `x` an object of class `timeDate`.

Value

returns an integer of length 1.

Examples

```r
## timCalendar -
tC = timeCalendar()

## length -
length(tC)
```
**Description**

Lists supported financial centers.

**Usage**

```r
listFinCenter(pattern = ".*")
```

**Arguments**

- `pattern` a pattern character string as required by the `grep` function.

**Details**

The function `rulesFinCenter`, lists the daylight saving rules for a selected financial center. There is no dependency on the POSIX implementation of your operating system because all time zone and day light saving time information is stored locally in ASCII files.

**Value**

returns a list of supported financial centers.

**Examples**

```r
## myFinCenter - the global setting currently used:
getRmetricsOptions("myFinCenter")

## Other Financial Centers:
listFinCenter("Asia/")
listFinCenter("^A") # all beginning with "A"
listFinCenter("^[A]") # all *not* beginning with "A"
listFinCenter(".*/L") # cities with L#

stopifnot(identical(sort(listFinCenter())), ## 'A' and 'not A' == everything:
  sort(union(listFinCenter("^A"),
            listFinCenter("^[A]")))))
```
### listHolidays

**List of Holidays**

**Description**

Returns the list of holidays.

**Usage**

```r
listHolidays(pattern = ".*")
```

**Arguments**

- `pattern` a pattern character string as required by the `grep` function.

**Value**

returns a list of holidays as a character vector.

**Examples**

```r
## listHolidays -

# All Holidays:
listHolidays()

# Local Swiss Holidays:
listHolidays("CH")
```

### midnightStandard

**Midnight Standard**

**Description**

Corrects 'timeDate' objects if they do not fulfill the ISO8601 midnight standard.

midnightStandard2() relies on `strptime` wherever possible, and there simply returns `as.POSIXct(strptime(charvec, format), tz)`.

**Usage**

```r
midnightStandard (charvec, format)
midnightStandard2(charvec, format)
```

**Arguments**

- `charvec` a character string or vector of dates and times.
- `format` a string, the format specification of the input character vector.
Value

midnightStandard returns a character and midnightStandard2 a POSIXct object.

Examples

ch <- "2007-12-31 24:00"
midnightStandard(ch)
(ms2 <- midnightStandard2(ch))
class(ms2)

---

### myFinCenter Variable

#### Description

A character string with the name of my financial center.

#### Note

Can be modified by the user to his own or any other financial center. The default is "GMT". To list all supported financial center use the function listFinCenter.

#### See Also

- listFinCenter

#### Examples

```r
### myFinCenter - the global setting currently used:
getRmetricsOptions("myFinCenter")

### Change to another Financial Center:
# setRmetricsOptions(myFinCenter = "Zurich")

### Do not take care about DST ...
# setRmetricsOptions(myFinCenter = "GMT")
```
### myUnits

**Frequency of date/time Units**

**Description**

A variable with the frequency of date/units.

**Value**

returns the the date/time units, a character value. By default "days".

**Examples**

```r
## myUnits -
getRmetricsOptions("myUnits")
```

### names-methods

**The Names of a timeDate Object**

**Description**

Functions to get or set the names of a timeDate object.

**Usage**

```r
## S4 method for signature 'timeDate'
names(x)
## S4 replacement method for signature 'timeDate'
names(x) <- value
```

**Arguments**

- `x` an object of class `timeDate`.
- `value` a character vector of up to the same length as `x`, or 'NULL'.

**Examples**

```r
td <- timeCalendar()
td
names(td) <- LETTERS[seq_along(td)]
td
```
Description

Computes the date for the n-th or last occurrence of a n-day in year/month.

Usage

```r
timeNthNdayInMonth(charvec, nday = 1, nth = 1, format = "%Y-%m-%d",
zone = "", FinCenter = "")
```

```r
timeLastNdayInMonth(charvec, nday = 1, format = "%Y-%m-%d",
zone = "", FinCenter = "")
```

Arguments

- `charvec`: a character vector of dates and times.
- `nday`: an integer vector with entries ranging from \(0\) (Sunday) to \(6\) (Saturday).
- `nth`: an integer vector numbering the n-th occurrence.
- `format`: the format specification of the input character vector.
- `zone`: the time zone or financial center where the data were recorded.
- `FinCenter`: a character with the location of the financial center named as "continent/city".

Value

returns an object of class `timeDate`.

For function `timeNthNdayInMonth` the n-th occurrence of a n-day (\(n = 1,...,5\)) in year, month, and for `timeLastNdayInMonth` the last n-day in year, month will be returned.

Examples

```r
## timeNthNdayInMonth -
# What date is the second Monday in April 2004 ?
timeNthNdayInMonth("2004-04-01", 1, 2)

## timeLastNdayInMonth -
# What date has the last Tuesday in May, 1996 ?
timeLastNdayInMonth("1996-05-01", 2)
```
**onOrAfter**

*OnOrAfter/Before Dates*

**Description**

Compute the date that is a "on-or-after" or "on-or-before" ans n-day.

**Usage**

```r
timendayonorafter(charvec, nday = 1, format = "%Y-%m-%d", zone = "", FinCenter = "")
timendayonorbefore(charvec, nday = 1, format = "%Y-%m-%d", zone = "", FinCenter = "")
```

**Arguments**

- `charvec`: a character vector of dates and times.
- `nday`: an integer vector with entries ranging from 0 (Sunday) to 6 (Saturday).
- `format`: the format specification of the input character vector.
- `zone`: the time zone or financial center where the data were recorded.
- `FinCenter`: a character with the location of the financial center named as "continent/city".

**Value**

returns an object of class `timeDate`.

`timendayonorafter` returns the date in the specified month that is a n-day (e.g. Sun-day) on or after the given date. Month and date are given through the argument `charvec`.

For the function `timendayonorbefore` the date that is a n-day on or before the given date will be returned.

**Examples**

```r
## Date as character String:
charvec = "2006-04-16"

## timendayonorafter
# What date has the first Monday on or after March 15, 1986?
timendayonorafter("1986-03-15", 1)

## timendayonorbefore
# What date has Friday on or before April 22, 1977?
timendayonorbefore("1986-03-15", 5)
```
periods  Rolling periods

Description

Returns start and end dates for a rolling periods

Usage

periods(x, period = "12m", by = "1m", offset = "0d")
periodicallyRolling(x, period = "52w", by = "4w", offset = "0d")
monthlyRolling(x, period = "12m", by = "1m")

Arguments

x  an object of class timeDate.
period  a span string, consisting of a length integer and a unit value, e.g. "52w" for 52 weeks.
by  a span string, consisting of a length integer and a unit value, e.g. "4w" for 4 weeks.
offset  a span string, consisting of a length integer and a unit value, e.g. "0d" for no offset.

Details

Periodically Rolling - Allowed unit values are "m" for 4 weeks, "w" for weeks, "d" for days, "H" for hours, "M" for minutes, and "S" for seconds.

Monthly Calendar Rolling - The only allowed allowed unit value is "m" for monthly periods. Express a quarterly period by "3m", a semester by "6m", a year by "12m" etc.

Examples

```r
## Create Time Sequence -
x <- timeSequence(from = "2001-01-01", to = "2009-01-01", by = "day")

## Generate Periods -
periods(x, "12m", "1m")
periods(x, "52w", "4w")

## Roll Periodically -
periodicallyRolling(x)

## Roll Monthly -
monthlyRolling(x)
```
Description

Plot methods for `timeDate` objects.

Usage

```
## S4 method for signature 'timeDate'
plot(x, y, ...)
## S4 method for signature 'timeDate'
lines(x, y, ...)
## S4 method for signature 'timeDate'
points(x, y, ...)

axis.timeDate(side, x, at, format = NULL, labels = TRUE, ...)

## S3 method for class 'timeDate'
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`, `at` an object of class `timeDate`.
- `side` an integer specifying which side of the plot the axis is to be drawn on. The axis is placed as follows: 1=below, 2=left, 3=above and 4=right.
- `format` a POSIX format string, e.g. "%Y-%m-%d".
- `labels` either a logical value specifying whether annotations are to be made at the tickmarks, or a vector of character strings to be placed at the tickpoints.
- `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.
- `...` arguments passed to other methods.

Value

returns a summary report of the details of a `timeDate` object. This includes the starting and end date, the number of dates the format and the financial center in use.
Note

These S3 methods will become S4 methods in the future.

Examples

```r
## timeCalendar
x <- timeCalendar()
y <- rnorm(12)

## Plotting
plot(x, y, type = "l")
points(x, y, pch = 19, col = "red")

plot(x, y, type = "l", xaxt = "n")
axis.timeDate(1, at = x[c(1, 3, 5, 7, 9, 11)], format = "%b")
axis.timeDate(1, at = x[12], format = "%Y")
```

Description

replicates a 'timeDate' object.

Usage

```r
## S3 method for class 'timeDate'
rep(x, ...)
```

Arguments

- `x`: an object of class timeDate.
- `...`: arguments passed to other methods.

Value

returns an object of class "timeDate".

Examples

```r
## c
# Create Character Vectors:
dts
tms = c("23:12:55", "10:34:02", "08:30:00", "11:18:23")
tms
```
Reverting 'timeDate' Objects

Description
Reverts a 'timeDate' object.

Usage
```r
## S3 method for class 'timeDate'
rev(x)
```

Arguments
- `x`: an object of class `timeDate`.

Value
returns an object of class "timeDate".

Examples
```r
## c -
# Create Character Vectors:
dts
tms = c( "23:12:55", "10:34:02", "08:30:00", "11:18:23")
tms
```
```r
## "+/-" -
# Add One Day to a Given timeDate Object:
GMT = timeDate(dts, zone = "GMT", FinCenter = "GMT")
GMT
ZUR = timeDate(dts, zone = "GMT", FinCenter = "Europe/Zurich")
ZUR
```
RmetricsOptions

Rmetrics Option Settings

Description

Allow the user to set and examine a variety of global options which affect the way in which Rmetrics functions computes and displays its results.

Usage

setRmetricsOptions(...)
getRmetricsOption(x, unset = "")

Arguments

unset a character string holding the return value is x is not set.

x a character string holding an option name.

... any options can be defined, using name = value or by passing a list of such tagged values.

round Rounding and Truncating 'timeDate' Objects

Description

Rounds and truncates objects of class 'timeDate'.

Usage

## S3 method for class 'timeDate'
round(x, digits = c("days", "hours", "mins"))

## S3 method for class 'timeDate'
trunc(x, units = c("days", "hours", "mins"), ...)
Arguments

digits, units a character string denoting the date/time units in which the results are desired.
x an object of class \texttt{timedate}.
... arguments passed to other methods.

Value

The two functions \texttt{round} and \texttt{trunc} allow to round or to truncate \texttt{timedate} objects to the specified unit and return them as \texttt{timedate} objects. - Note, that is an inconsistency \texttt{round} uses \texttt{digits} as argument and not \texttt{units}.

Examples

## round -

## truncate -

---

\textbf{rulesFinCenter} \quad \textit{Financial Centers DST Rules}

Description

Returns DST rules for a financial center.

Usage

\begin{verbatim}
rulesFinCenter(FinCenter = "")
\end{verbatim}

Arguments

\begin{verbatim}
FinCenter a character with the the location of the financial center named as 'continent/city'.
\end{verbatim}

Details

The function \texttt{rulesFinCenter}, lists the daylight saving rules for a selected financial center. There is no dependency on the POSIX implementation of your operating system because all time zone and day light saving time information is stored locally in ASCII files.

Value

returns a list of time zones and DST rules available in the database.

Examples

## rulesFinCenter -

\begin{verbatim}
rulesFinCenter("Zurich")
\end{verbatim}
Resampling 'timeDate' Objects

Description

Resamples a 'timeDate' object.

Value

returns an object of class "timeDate".

Examples

```r
## c -
# Create Character Vectors:
dts
tms = c("23:12:55", "10:34:02", "08:30:00", "11:18:23")
tms

## "+/-" -
# Add One Day to a Given timeDate Object:
GMT = timeDate(dts, zone = "GMT", FinCenter = "GMT")
GMT
ZUR = timeDate(dts, zone = "GMT", FinCenter = "Europe/Zurich")
ZUR

## c -
# Concatenate and Replicate timeDate Objects:
c(GMT[1:2], ZUR[1:2])
c(ZUR[1:2], GMT[1:2])

## rep -
rep(ZUR[2], times = 3)
rep(ZUR[2:3], times = 2)
```

show-methods

Show Methods

Description

Show methods for 'timeDate' objects.

Methods

`object = "ANY"` Generic function.

`object = "timeDate"` Print function for objects of class "timeDate".
Examples

```r
## print | show -
print(timeCalendar())
```

<table>
<thead>
<tr>
<th>skewness</th>
<th>Skewness</th>
</tr>
</thead>
</table>

Description

Functions to compute skewness.

Usage

```r
skewness(x, ...)  
```

- Default S3 method:
  ```r
  skewness(x, na.rm = FALSE, method = c("moment", "fisher"), ...)
  ```
- S3 method for class 'data.frame'
  ```r
  skewness(x, ...)  
  ```
- S3 method for class 'POSIXct'
  ```r
  skewness(x, ...)  
  ```
- S3 method for class 'POSIXlt'
  ```r
  skewness(x, ...)  
  ```

Arguments

- `na.rm` a logical. Should missing values be removed?
- `method` a character string which specifies the method of computation. These are either "moment" or "fisher". The "moment" method is based on the definitions of skewness for distributions; these forms should be used when resampling (bootstrap or jackknife). The "fisher" method correspond to the usual "unbiased" definition of sample variance, although in the case of skewness exact unbiasedness is not possible.
- `x` a numeric vector or object.
- `...` arguments to be passed.

Value

`skewness`

returns the value of the statistics, a numeric value. An attribute which reports the used method is added.

See Also

link{kurtosis}. 
Examples

```r
## mean -
## var -
# Mean, Variance:
r = rnorm(100)
mean(r)
var(r)

## skewness -
skewness(r)
```

Description

Sorts a 'timeDate' object.

Usage

```r
## S3 method for class 'timeDate'
sort(x, ...)
```

Arguments

- `x` an object of class `timeDate`.
- `...` arguments passed to other methods.

Value

returns an object of class "timeDate".

Examples

```r
## c -
# Create Character Vectors:
dts
tms = c( "23:12:55", "10:34:02", "08:30:00", "11:18:23")
tms

## 
# Add One Day to a Given timeDate Object:
GMT = timeDate(dts, zone = "GMT", FinCenter = "GMT")
GMT
ZUR = timeDate(dts, zone = "GMT", FinCenter = "Europe/Zurich")
ZUR
```
## Terminal Times and Range

### Description

Extracts the time the first or last observation was taken, or computes the range.

### Usage

```r
## S3 method for class 'timeDate'
start(x, ...)
```

```r
## S3 method for class 'timeDate'
end(x, ...)
```

```r
## S3 method for class 'timeDate'
min(..., na.rm = FALSE)
```

```r
## S3 method for class 'timeDate'
max(..., na.rm = FALSE)
```

```r
## S3 method for class 'timeDate'
rangex, ..., na.rm = FALSE)
```

### Arguments

- **x**: an object of class `timeDate`.
- **...**: `[start][end]` - not used, `[min][max]` - `timeDates` objects.
- **na.rm**: not used.

### Details

Note, the series will be time ordered before the start or end time stamps are extracted. Sorting is done in the way that the first observation appears in time before the last observation.
subset

Value

returns an object of class `timeDate`.

Examples

```r
## timeCalendar -
# Random Calendar Dates:
tr = sample(timeCalendar())
sort(tr)
tr

## start | end -
start(tr)
end(tr)

## The First and Last Time Stamp:
tr[1]
tr[length(tr)]
rev(tr)[1]

## The Range:
c(start(tr), end(tr))
range(tr)
```

Description

Extracts or replaces subsets from `timeDate` objects.

Value

returns an object of class `timeDate`.

Examples

```r
## timeCalendar -
tS = timeCalendar()

## [ -
# Subsetting Second Quarter:
tS[4:6]

## [<-
# Replacing:
```
## Summary Methods

**Summary Method**

**Description**

Summarizes details of a 'timeDate' object.

**Usage**

```r
## S3 method for class 'timeDate'
summary(object, ...)
```

**Arguments**

- `object`: an object of class `timeDate`.
- `...`: arguments passed to other methods.

**Value**

returns a summary report of the details of a `timeDate` object. This includes the starting and end date, the number of dates the format and the financial center in use.

**Note**

This S3 method will become in the future a S4 method

**Examples**

```r
## summary -
tC = timeCalendar()
summary(tC)
```

---

## System Time as 'timeDate' Object

**Description**

Returns system time as an object of class 'timeDate'.

**Usage**

```r
Sys.timeDate(FinCenter = "")
```

**Arguments**

- `FinCenter`: a character with the the location of the financial center named as "continent/city".
Value

returns the system time as class "timeDate" object.

Examples

## Sys.time -

```r
direct
Sys.time()
```

```r
# transformed from "POSIX(c)time"
timeDate(Sys.time())
```

```r
# Local Time in Zurich
timeDate(Sys.time(), FinCenter = "Zurich")
```

---

**Description**

Create a 'timeDate' object from calendar atoms.

**Usage**

```r
timeCalendar(y = getRmetricsOptions("currentYear"), m = 1:12, d = 1,
             h = 0, min = 0, s = 0,
             zone = "", FinCenter = "")
```

**Arguments**

- `y, m, d`: calendar years (e.g. 1997), defaults are 1960, calendar months (1-12), defaults are 1, and calendar days (1-31), defaults are 1,

- `h, min, s`: hours of the days (0-23), defaults are 0, minutes of the days (0-59), defaults are 0, and seconds of the days (0-59), defaults are 0,

- `zone`: a character string, denoting the time zone or financial center where the data were recorded.

- `FinCenter`: a character with the the location of the financial center named as "continent/city".

**Value**

returns a S4 object of class "timeDate".
Examples

```r
## timeCalendar -

# Current Year:
getRmetricsOptions("currentYear")

# 12 months of current year
timeCalendar()

timeCalendar(m = c(9, 1, 8, 2), d = c(28, 15, 30, 9),

timeCalendar(m = c(9, 1, 8, 2), d = c(28, 15, 30, 9),

timeCalendar(h = c(9, 14), min = c(15, 23))
```

**Description**

Create a 'timeDate' object from scratch using a character vector.

**Usage**

```r
timeDate(charvec, format = NULL, zone = "", FinCenter = "")
strptimeDate(x, format = whichFormat(x), tz = "")
```

**Arguments**

- `charvec` a character string or vector of dates and times.
- `format` the format specification of the input character vector.
- `tz` a character with the the location of the financial center named as "continent/city", or short "city".
- `zone` the time zone or financial center where the data were recorded.
- `x` a character string or vector of dates and times.
- `FinCenter` a character with the the location of the financial center named as "continent/city".

**Value**

returns an object of class timeDate.
Examples

```r
## timeDate -

# Character Vector Strings:
tms = c("23:12:55", "10:34:02", "08:30:00", "11:18:23")

dts; tms
t1 <- timeDate(dts, format = "%Y-%m-%d", FinCenter = "GMT")
t1

stopifnot(identical(t1, timeDate(dts, FinC = "GMT"))) # auto-format
timeDate(dts, format = "%Y-%m-%d", FinCenter = "Europe/Zurich")
timeDate(paste(dts, tms), format = "%Y-%m-%d %H:%M:%S",
    zone = "GMT", FinCenter = "GMT")
timeDate(paste(dts, tms),
    zone = "Europe/Zurich", FinCenter = "Europe/Zurich")
timeDate(paste(dts, tms), format = "%Y-%m-%d %H:%M:%S",
    zone = "GMT", FinCenter = "Europe/Zurich")

## Non Standard Format:
timeDate(paste(20:31, "03.2005", sep="."), format = "%d.%m.%Y")

## Note, ISO and American Formats are Auto-Detected:
timeDate("2004-12-31", FinCenter = "GMT")
timeDate("12/11/2004", FinCenter = "GMT")
timeDate("1/31/2004") # auto-detect American format

## From POSIXt, and using NAs
## lsec <- as.POSIXlt(.
## lsec[c(2,4:6)] <- NA
## timeDate(lsec)

## dtms <- paste(dts,tms)
## dtms[2:3] <- NA
## timeDate(dtms, FinCenter = "Europe/Zurich") # but in GMT
```
Description

The class 'timeDate' represents date and time objects.

Details

For the management of chronological objects under R three concepts are available: The first is the implementation of date and time in R's \texttt{chron} package neglecting locals, time zones and day light saving times. This approach is in most cases appropriate for economic time series. The second approach, available in R's base package implements the POSIX standard to date and time objects, named "\texttt{POSIXt}".

Unfortunately, the representation of these objects is in some cases operating system dependent and especially under MS Windows several problems appeared over the time in the management of time zones and day light saving times. Rmetrics overcomes these difficulties with POSIX objects and introduce a new S4 class of 'timeDate' objects which allow for powerful methods to represent dates and times in different financial centers around the world.

Many of the basic functionalities of these objects are in common with S-Plus' \texttt{timeDate} objects and thus many of your privately written functions for SPlus/FinMetrics may also be used within the R/Rmetrics environment.

A major difference is the time zone concept which is replaced by the "Financial Center" concept. The \texttt{FinCenter} character variable specifies where you are living and at which financial center you are working. With the variable \texttt{myFinCenter} you can overwrite the default setting with your personal settings. With the specification of the \texttt{FinCenter} your system knows what rules rules for day light saving times should be applied, what is your holiday calendar, what is your currency, what are your interest rate conventions. (Not all specifications are already implemented.) Many other aspects can be easily accessed when a financial center is named. So we can distinguish between Frankfurt and Zurich, which both belong to the same time zone, but differed in DST changes in the eighties and have different holiday calendars. Furthermore, since the underlying time refers to "GMT" and DST rules and all other information is available in local (ASCII) databases, we are sure, that R/Rmetrics delivers with such a date/time concept on every computer independent of the operating system in use, identical results.

Another important feature of the "\texttt{timeDate}" concept used here is the fact that we don't rely on American or European ways to write dates. We use consequently the ISO-8601 standard for date and time notations.

Generation of 'timeDate' Objects

We have defined a \texttt{timeDate} class which is in many aspects similar to the S-Plus class with the same name, but has also some important advantageous differences. The S4 class has four Slots, the \texttt{Data} slot which holds date and time as 'POSIXct' objects in the standard ISO-8601 format, the \texttt{Dim} slot which gives the dimension of the data object (i.e. its length), the format specification slot and the \texttt{FinCenter} slot which holds the name of the financial center. By default this is the value

Three functions allow to cgenerate date/time objects: \texttt{timeDate} from character vectors, \texttt{timeCalendar} from date and time atoms, and \texttt{timeSequence} from a "from/to" or from a "from/length" sequence specification. Note, time zone transformations are easily handled by the \texttt{timeDate} functions which can also take \texttt{timeDate} and \texttt{POSIXt} objects as inputs, while transforming them between financial centers and/or time zones specified by the arguments zone and \texttt{FinCenter}. Finally the
function Sys.timeDate returns current system time in form of a `timeDate` object.

**Tests and Representation of `timeDate` Objects:**
Rmetrics has implemented several methods to represent `timeDate` objects. For example, the print method returns the date/time in square "[]" brackets to distinguish the output from other date and time objects. On top of the date and time output the name of the FinCenter is printed. The summary method returns a printed report with information about the `timeDate` object. Finally, the format methods allows to transform objects into a ISO conform formatted character strings.

**Mathematical Operations:**
Rmetrics supports methods to perform many mathematical operations. Included are methods to extract or to replace subsets from `timeDate` objects, to perform arithmetic "+" and "-" operations, to group Ops generic functions, to return suitably lagged and iterated differences `diff`, to return differences `difftimeDate` of two `timeDate` objects, to concatenate objects, to replicate objects, to `round` objects, to truncate objects using `trunc`, to extract the first or last entry of a vector, to `sort` the objects of the elements of a date/time vector, and to revert 'timeDate’ vector objects, among other functions.

**Transformation of Objects:**
Rmetrics has also functions to transform date/time objects between different representations. Included are methods to transform `timeDate` objects to character strings, to data frames, to POSIXct or POSIXlt objects, to `julian` counts. One can extract date/time atoms from calendar dates, and the `months` atoms from a `timeDate` object.

**Objects from the Class**
Objects can be created for example by calls of the functions `timeDate`, `timeCalender` and `timeCalendar` among others.

**Slots**
- **data**: Object of class "POSIXct": a vector of POSIXct dates and times always related to "GMT".
- **format**: Object of class "character": a character string denoting the format specification of the input Data character vector.
- **FinCenter**: Object of class "character": a character string with the the location of the financial center named as "continent/city", or just "city".

**Methods**
- `show` signature(object = "timeDate"): prints an object of class 'timeDate'.

**Note**
Originally, these functions were written for Rmetrics users using R and Rmetrics under Microsoft’s Windows XP operating system where time zones, daylight saving times and holiday calendars are not or insufficiently supported.
The usage of the Ical Library and the introduction of the FinCenter concept was originally developed for R Version 1.5. The `timeDate` and `timeSeries` objects were added for R Version 1.8.1. Minor changes were made to adapt the functions for R Version 1.9.1. As a consequence, newer concepts like the `Date` objects were not yet considered and included in this collection of date and time concepts. With R Version 2.3.0 a major update has been made adding many new generic functions and renaming a few already existing functions, please be aware of this.

Note, the date/time conversion from an arbitrary time zone to GMT cannot be unique, since date/time objects appear twice during the hour when DST changes and the isdt flag was not recorded. A bookkeeping which takes care if DST is effective or not is not yet included. However, in most applications this is not necessary since the markets are closed on weekends, especially at times when DST usually changes. It is planned for the future to implement the DST supporting this facility.

The ISO-8601 midnight standard has been implemented. Note, that for example "2005-01-01 24:00:00" is accepted as a valid date/time string.

Also available is an automated format recognition, so the user has not longer specify the format string for the most common date/time formats.

Examples

```r
## Examples for Objects of class 'timeDate':

## timeDate -

Sys.timeDate()  # direct
timeDate(Sys.time())  # transformed from "POSIXct"

# Local Time in Zurich
timeDate(Sys.time(), FinCenter = "Zurich")

# Character Vector Strings:
dts
tms = c("23:12:55", "10:34:02", "08:30:00", "11:18:23")
tms

t1 <- timeDate(dts, format = "%Y-%m-%d", FinCenter = "GMT")
t1
stopifnot(identical(t1, timeDate(dts, FinC = "GMT")))  # auto-format
timeDate(dts, format = "%Y-%m-%d", FinCenter = "Europe/Zurich")
timeDate(paste(dts, tms), format = "%Y-%m-%d %H:%M:%S",
zone = "GMT", FinCenter = "GMT")
timeDate(paste(dts, tms),
zone = "Europe/Zurich", FinCenter = "Europe/Zurich")
timeDate(paste(dts, tms), format = "%Y-%m-%d %H:%M:%S",
zone = "GMT", FinCenter = "Europe/Zurich")
```

## timeDateMathOps

### Non Standard Format:
```r
timeDate(paste(20:31, "03.2005", sep="."), format = "%d.%m.%Y")
```

# Note, ISO and American Formats are Auto-Detected:
```r
timeDate("2004-12-31", FinCenter = "GMT")
timeDate("12/11/2004", FinCenter = "GMT")
timeDate("1/31/2004")  # auto-detect American format
```

## timeCalendar -
```r
getMetricsOptions("currentYear")
timeCalendar()  # 12 months of current year
timeCalendar(m = c(9, 1, 8, 2), d = c(28, 15, 30, 9),
timeCalendar(m = c(9, 1, 8, 2), d = c(28, 15, 30, 9),
timeCalendar(h = c(9, 14), min = c(15, 23))
```

## timeSequence -
```r
timeSequence(from = "2004-03-12", to = "2004-04-11",
  format = "%Y-%m-%d", FinCenter = "GMT")
timeSequence(from = "2004-03-12", to = "2004-04-11",
  format = "%Y-%m-%d", FinCenter = "Europe/Zurich")
```

## print | summary | format -
```r
tC = timeCalendar()
print(tC)
summary(tC)
format(tC)
```
Description

Functions for mathematical and logical operations on 'timeDate' objects.

The functions are:

- `Ops, timeDate` Group 'Ops' generic functions for 'timeDate' objects,
- `+, timeDate` Performs arithmetic + operation on 'timeDate' objects,
- `- , timeDate` Performs arithmetic - operation on 'timeDate' objects.

Usage

```r
## S4 method for signature 'timeDate, timeDate'
Ops(e1, e2)
```

Arguments

- `e1, e2` usually objects of class `timeDate`, in the case of addition and subtraction `e2` may be of class `numeric`.

Value

- `Ops.timeDate` these are functions for mathematical operations. Group `Ops` are generic functions which manage mathematical operations.
- `+, timeDate`
- `- , timeDate`

The plus operator `+` performs arithmetic `+` operation on `timeDate` objects, and the minus operator `-` returns a `difftime` object if both arguments `e1` and `e2` are `timeDate` objects, or returns a `timeDate` object `e2` seconds earlier than `e1`.

Examples

```r
## Create Character Vectors:
dts
tms = c( "23:12:55", "10:34:02", "08:30:00", "11:18:23")
tms

## "+/-" -
# Add One Day to a Given timeDate Object:
GMT = timeDate(dts, zone = "GMT", FinCenter = "GMT")
GMT
ZUR = timeDate(dts, zone = "GMT", FinCenter = "Europe/Zurich")
```
timeSequence

Regularly spaced 'timeDate' objects

Description

Create a regularly spaced object of class timeDate.

Usage

```r
timeSequence(from = Sys.time(), to = NULL, by = "sec", length.out = NULL,
format = NULL, zone = "", FinCenter = "")
#
## S3 method for class 'timeDate'
## seq(from, to, by, length.out = NULL, along.with = NULL, ...)
```

Arguments

- `from, to` starting date, required, and end date, optional. If supplied, `to` must be after (later than) `from`.
- `by` a character string, containing one of "sec", "min", "hour", "day", "week", "month" or "year". This can optionally be preceded by an integer and a space, or followed by "s".
  - character string "quarter" that is equivalent to "3 months".
  - A number, taken to be in seconds.
  - A object of class 'difftime'
- `length.out` length.out integer, optional. Desired length of the sequence, if specified "to" will be ignored.
- `along.with` Take the length from the length of this argument.
- `format` the format specification of the input character vector.
- `zone` the time zone or financial center where the data were recorded.
- `FinCenter` a character with the the location of the financial center named as "continent/city".
- `...` arguments passed to other methods.

Value

an object of class "timeDate".

Note

timeSequence() is a wrapper for the "timeDate" method of seq(), and that has been closely modeled after base R's POSIXt method, seq.POSIXt.
## Examples

```r
## autodetection of format:
(t1 <- timeSequence(from = "2004-03-12", to = "2004-04-11"))

stopifnot( ## different formats even:
  identical(t1, timeSequence(from = "2004-03-12", to = "11-Apr-2004")),
  identical(t1, ## explicit format and FinCenter :
    timeSequence(from = "2004-03-12", to = "2004-04-11",
                format = "%Y-%m-%d", FinCenter = "GMT")))

## observe "switch to summer time":
timeSequence(from = "2004-03-12", to = "2004-04-11",
             FinCenter = "Europe/Zurich")
```

### Description

Makes a 'timeDate' object unique.

### Usage

```r
## S3 method for class 'timeDate'
unique(x, ...)
```

### Arguments

- `x` an object of class `timeDate`
- `...` arguments passed to other methods.

### Value

returns an object of class "timeDate".

### Examples

```r
## c -
# Create Character Vectors:
dts
tms = c("23:12:55", "10:34:02", "08:30:00", "11:18:23")
tms

## "+/-" -
# Add One Day to a Given timeDate Object:
GMT = timeDate(dts, zone = "GMT", FinCenter = "GMT")
```

whichFormat

GMT
ZUR = timeDate(dts, zone = "GMT", FinCenter = "Europe/Zurich")
ZUR

## c -
# Concatenate and Replicate timeDate Objects:
c(GMT[1:2], ZUR[1:2])
c(ZUR[1:2], GMT[1:2])

## rep -
rep(ZUR[2], times = 3)
rep(ZUR[2:3], times = 2)

<table>
<thead>
<tr>
<th>whichFormat</th>
<th>Format Recognition</th>
</tr>
</thead>
</table>

Description

Tries to recognize the date/time format.

Usage

whichFormat(charvec, silent = FALSE)

Arguments

charvec a character string or vector of dates and times.
silent a logical flag. Should a warning be printed if the format cannot be recognized?

Value

returns a format string.

Examples

## midnightStandard -
whichFormat("2007-12-31 24:00")
Time Windows

Description

Extract the subset of a 'timeDate' object observed between two time stamps.

Usage

## S3 method for class 'timeDate'
window(x, start, end, ...)

## S3 method for class 'timeDate'
cut(x, from, to, ...)

Arguments

- from, to: starting date, required, and end date, optional. If supplied to must be after from.
- start, end: starting date, required, and end date, optional. If supplied to must be after from.
- x: an object of class timeDate.
- ...: arguments passed to other methods.

Value

returns an object of class timeDate.

Examples

```r
## timeCalendar -
# Monthly Dates in Current Year:
tS = timeCalendar()
tS

## window -
# 2nd Quarter Window:
tS[4:6]
window(tS, tS[4], tS[6])
```
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