

# Package ‘DTSg’

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**Type** Package

**Title** A Class for Working with Time Series Data Based on 'data.table'  
and 'R6' with Largely Optional Reference Semantics

**Version** 1.1.3

**Description** Basic time series functionalities such as listing of missing values, application of arbitrary aggregation as well as rolling (asymmetric) window functions and automatic detection of periodicity. As it is mainly based on 'data.table', it is fast and (in combination with the 'R6' package) offers reference semantics. In addition to its native R6 interface, it provides an S3 interface for those who prefer the latter. Finally yet importantly, its functional approach allows for incorporating functionalities from many other packages.

**License** MIT + file LICENSE

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**BugReports** <https://github.com/gisler/DTSg/issues>

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aggregate.DTSg	<i>Aggregate values</i>
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**Description**

Applies a temporal aggregation level function to the *dateTime* column of a *DTSg* object and aggregates its values column-wise to the function's temporal aggregation level utilising one or more provided summary functions. Additionally, it sets the object's *aggregated* field to TRUE.

**Usage**

```
## S3 method for class 'DTSg'
aggregate(
  x,
  funby,
  fun,
  ...,
  cols = self$cols(class = "numeric"),
```

```

    n = FALSE,
    ignoreDST = FALSE,
    multiplier = 1L,
    funbyHelpers = NULL,
    funbyApproach = self$funbyApproach,
    clone = getOption("DTSgClone")
  )

```

### Arguments

x	A <a href="#">DTSg</a> object (S3 method only).
funby	One of the temporal aggregation level functions described in <a href="#">TALFs</a> or a user defined temporal aggregation level function. See corresponding section for further information.
fun	A summary function, (named) <a href="#">list</a> of summary functions or (named) character vector specifying summary functions applied column-wise to all the values of the same temporal aggregation level. The return value(s) must be of length one. See corresponding section for further information.
...	Further arguments passed on to fun.
cols	A character vector specifying the columns to aggregate. Another possibility is a character string containing either comma separated column names, for example, "x,y,z", or the start and end column separated by a colon, for example, "x:z".
n	A logical specifying if a column named .n giving the number of values per temporal aggregation level shall be added. See corresponding section for further information.
ignoreDST	A logical specifying if day saving time shall be ignored by funby. See corresponding section for further information.
multiplier	A positive integerish value "multiplying" the temporal aggregation level of certain <a href="#">TALFs</a> . See corresponding section for further information.
funbyHelpers	An optional <a href="#">list</a> with helper data passed on to funby. See corresponding section for further information.
funbyApproach	A character string specifying the flavour of the applied temporal aggregation level function. Either "base", which utilises <a href="#">as.POSIXct</a> , or "fasttime", which utilises <a href="#">fasttime::fastPOSIXct</a> , or "RcppCCTZ", which utilises <a href="#">RcppCCTZ::parseDatetime</a> as the main function for transforming timestamps.
clone	A logical specifying if the object shall be modified in place or if a deep clone (copy) shall be made beforehand.

### Value

Returns an aggregated [DTSg](#) object.

### User defined TALFs, TALFs helper data and multiplier

User defined temporal aggregation level functions have to return a [POSIXct](#) vector of the same length as the time series and accept two arguments: a [POSIXct](#) vector as its first and a [list](#) with helper data as its second. The default elements of this [list](#) are as follows:

- *timezone*: Same as the `timezone` field.
- *ignoreDST*: Same as the `ignoreDST` argument.
- *periodicity*: Same as the `periodicity` field.
- *na.status*: Same as the `na.status` field.
- *multiplier*: Same as the `multiplier` argument.
- *funbyApproach*: Same as the `funbyApproach` argument.

Any additional element specified in the `funbyHelpers` argument is appended to the end of the helper data `list`. In case `funbyHelpers` contains an *ignoreDST*, *multiplier* or *funbyApproach* element, it takes precedence over the respective method argument. *timezone*, *periodicity* and *na.status* elements are rejected, as they are always taken directly from the object.

The temporal aggregation level of certain `TALFs` can be adjusted with the help of the `multiplier` argument. A multiplier of 10, for example, makes `byY_____` aggregate to decades instead of years. Another example is a multiplier of 6 provided to `by_m_____`. The function then aggregates all months of all first and all months of all second half years instead of all months of all years separately. This feature is supported by the following `TALFs` of the package:

- `byY_____`
- `byYm_____`
- `byYmdH__` (UTC and equivalent as well as all Etc/GMT time zones only)
- `byYmdHM_`
- `byYmdHMS`
- `by_m_____`
- `by___H__` (UTC and equivalent as well as all Etc/GMT time zones only)
- `by____M_`
- `by____S`

### Summary functions

Some examples for `fun` are as follows:

- `mean`
- `list(min = min, max = max)`
- `c(sd = "sd", var = "var")`

A `list` or character vector must have names in case more than one summary function is provided. The method can benefit from `data.table`'s *GForce* optimisation in case a character vector specifying summary functions is provided.

### Number of values per temporal aggregation level

Depending on the number of columns to aggregate, the `.n` column contains different counts:

- One column: The counts are calculated from the columns' values disregarding any missing values. This means that missing values are always stripped regardless of the value of a possible `na.rm` argument.
- More than one column: The counts are calculated from the `.dateTime` column including all missing values.

### Ignore day saving time

ignoreDST tells a temporal aggregation level function if it is supposed to ignore day saving time while transforming the timestamps. This can be a desired feature for time series strictly following the position of the sun such as hydrological time series. Doing so ensures that diurnal variations are preserved by all means and all intervals are of the “correct” length, however, a possible limitation might be that the day saving time shift is invariably assumed to be one hour long. This feature requires that the periodicity of the time series was recognised and is supported by the following [TALFs](#) of the package:

- [byY\\_\\_\\_\\_\\_](#)
- [byYQ\\_\\_\\_\\_\\_](#)
- [byYm\\_\\_\\_\\_\\_](#)
- [byYmd\\_\\_\\_\\_](#)
- [by\\_Q\\_\\_\\_\\_\\_](#)
- [by\\_m\\_\\_\\_\\_\\_](#)
- [by\\_\\_\\_H\\_\\_](#)

### See Also

[cols](#), [getOption](#)

### Examples

```
# new DTSg object
x <- DTSg$new(values = flow)

# mean yearly river flows
## R6 method
x$aggregate(
  funby = byY_____,
  fun = "mean",
  na.rm = TRUE
)$print()

## S3 method
print(aggregate(
  x = x,
  funby = byY_____,
  fun = "mean",
  na.rm = TRUE
))

# variance and standard deviation of river flows per quarter
## R6 method
x$aggregate(
  funby = byYQ____,
  fun = c(var = "var", sd = "sd"),
  na.rm = TRUE
)$print()
```

```

## S3 method
print(aggregate(
  x = x,
  funby = byYQ____,
  fun = c(var = "var", sd = "sd"),
  na.rm = TRUE
))

# mean of river flows of all first and all second half years
## R6 method
x$aggregate(
  funby = by_m____,
  fun = "mean",
  na.rm = TRUE,
  multiplier = 6
)$print()

## S3 method
print(aggregate(
  x = x,
  funby = by_m____,
  fun = "mean",
  na.rm = TRUE,
  multiplier = 6
))

```

---

alter.DTSg

*Alter time series*


---

## Description

Shortens, lengthens, filters for a consecutive range, changes the periodicity and/or the status of missing values of a *DTSg* object.

## Usage

```

## S3 method for class 'DTSg'
alter(
  x,
  from = first(self$values(reference = TRUE)[[".dateTime"]]),
  to = last(self$values(reference = TRUE)[[".dateTime"]]),
  by = self$periodicity,
  rollback = TRUE,
  clone = getOption("DTSgClone"),
  na.status = self$na.status,
  ...
)

```

**Arguments**

x	A <a href="#">DTSg</a> object (S3 method only).
from	A <a href="#">POSIXct</a> timestamp in the same time zone as the time series or a character string coercible to one. Specifies the new start of the time series.
to	A <a href="#">POSIXct</a> timestamp in the same time zone as the time series or a character string coercible to one. Specifies the new end of the time series.
by	Specifies the new periodicity in one of the ways the by argument of <a href="#">seq.POSIXt</a> can be specified. Must be specified for time series with unrecognised periodicity. Time steps out of sync with the new periodicity are dropped.
rollback	A logical specifying if a call to <a href="#">rollback</a> shall be made when appropriate.
clone	A logical specifying if the object shall be modified in place or if a deep clone (copy) shall be made beforehand.
na.status	A character string. Either "explicit", which makes missing timestamps explicit according to the recognised periodicity, or "implicit", which removes timestamps with missing values on all value columns. Please note that <a href="#">DTSg</a> objects work best with explicitly missing values.
...	Not used (S3 method only).

**Value**

Returns a [DTSg](#) object.

**See Also**

[getOption](#), [subset](#), [nas](#)

**Examples**

```
# new DTSg object
x <- DTSg$new(values = flow)

# filter for the first two years
## R6 method
x$alter(
  from = "2007-01-01",
  to = "2008-12-31"
)$print()

## S3 method
print(alter(
  x = x,
  from = "2007-01-01",
  to = "2008-12-31"
))

# change periodicity to one month
## R6 method
x$alter(by = "1 month")$print()
```

```
## S3 method
print(alter(x = x, by = "1 month"))
```

---

clone.DTSg

*Clone object*


---

## Description

Clones (copies) a [DTSg](#) object. Merely assigning a variable representing a [DTSg](#) object to a new variable does not result in a copy of the object. Instead, both variables will reference and access the same data under the hood, i.e. changing one will also affect the other. This is not an issue when calling methods with the *DTSgClone* option or `clone` argument set to `TRUE`, but has to be kept in mind when setting fields, as they are always modified in place. See [DTSg](#) for further information.

## Usage

```
## S3 method for class 'DTSg'
clone(x, deep = FALSE, ...)
```

## Arguments

<code>x</code>	A <a href="#">DTSg</a> object (S3 method only).
<code>deep</code>	A logical specifying if a deep copy shall be made (for consistency with the <a href="#">R6::R6Class</a> the default is <code>FALSE</code> , but should generally be set to <code>TRUE</code> ).
<code>...</code>	Not used (S3 method only).

## Value

Returns a cloned [DTSg](#) object.

## See Also

[options](#)

## Examples

```
# new DTSg object
x <- DTSg$new(values = flow)

# make a deep copy
## R6 method
x$clone(deep = TRUE)

## S3 method
clone(x = x, deep = TRUE)
```



---

colapply.DTSg	<i>Apply function column-wise</i>
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---

## Description

Applies an arbitrary function to selected columns of a [DTSg](#) object.

## Usage

```
## S3 method for class 'DTSg'
colapply(
  x,
  fun,
  ...,
  cols = self$cols(class = "numeric")[1L],
  resultCols = NULL,
  suffix = NULL,
  helpers = TRUE,
  funby = NULL,
  ignoreDST = FALSE,
  multiplier = 1L,
  funbyHelpers = NULL,
  funbyApproach = self$funbyApproach,
  clone = getOption("DTSgClone")
)
```

## Arguments

x	A <a href="#">DTSg</a> object (S3 method only).
fun	A <a href="#">function</a> . Its return value must be of length one.
...	Further arguments passed on to fun.
cols	A character vector specifying the columns to apply fun to. Another possibility is a character string containing either comma separated column names, for example, "x,y,z", or the start and end column separated by a colon, for example, "x:z".
resultCols	An optional character vector of the same length as cols specifying the column names for the return values of fun. Another possibility is a character string containing comma separated column names, for example, "x,y,z". Non-existing columns are added and existing columns are overwritten. Columns are matched element-wise between cols and resultCols.
suffix	An optional character string. The return values of fun are added as new columns with names consisting of the columns specified in cols and this suffix. Existing columns are never overwritten. Only used when resultCols is not specified.
helpers	A logical specifying if helper data shall be handed over to fun. See corresponding section for further information.

funby	One of the temporal aggregation level functions described in <a href="#">TALFs</a> or a user defined temporal aggregation level function. Can be used to apply functions like <a href="#">cumsum</a> to a certain temporal level. See corresponding section and examples for further information.
ignoreDST	A logical specifying if day saving time shall be ignored by funby. See corresponding section for further information.
multiplier	A positive integerish value “multiplying” the temporal aggregation level of certain <a href="#">TALFs</a> . See corresponding section for further information.
funbyHelpers	An optional <a href="#">list</a> with helper data passed on to funby. See corresponding section for further information.
funbyApproach	A character string specifying the flavour of the applied temporal aggregation level function. Either "base", which utilises <a href="#">as.POSIXct</a> , or "fasttime", which utilises <a href="#">fasttime::fastPOSIXct</a> , or "RcppCCTZ", which utilises <a href="#">RcppCCTZ::parseDatetime</a> as the main function for transforming timestamps.
clone	A logical specifying if the object shall be modified in place or if a deep clone (copy) shall be made beforehand.

### Value

Returns a [DTSg](#) object.

### Helper data

In addition to the `...` argument, this method optionally hands over a [list](#) argument with helper data called `.helpers` to fun. This [list](#) contains the following elements:

- *.dateTime*: A [POSIXct](#) vector containing the *.dateTime* column.
- *periodicity*: Same as the [periodicity](#) field.
- *minLag*: A [difftime](#) object containing the minimum time difference between two subsequent timestamps.
- *maxLag*: A [difftime](#) object containing the maximum time difference between two subsequent timestamps.

### User defined TALFs, TALFs helper data and multiplier

User defined temporal aggregation level functions have to return a [POSIXct](#) vector of the same length as the time series and accept two arguments: a [POSIXct](#) vector as its first and a [list](#) with helper data as its second. The default elements of this [list](#) are as follows:

- *timezone*: Same as the [timezone](#) field.
- *ignoreDST*: Same as the `ignoreDST` argument.
- *periodicity*: Same as the [periodicity](#) field.
- *na.status*: Same as the [na.status](#) field.
- *multiplier*: Same as the `multiplier` argument.
- *funbyApproach*: Same as the `funbyApproach` argument.

Any additional element specified in the `funbyHelpers` argument is appended to the end of the helper data `list`. In case `funbyHelpers` contains an `ignoreDST`, `multiplier` or `funbyApproach` element, it takes precedence over the respective method argument. `timezone`, `periodicity` and `na.status` elements are rejected, as they are always taken directly from the object.

The temporal aggregation level of certain `TALFs` can be adjusted with the help of the `multiplier` argument. A multiplier of 10, for example, makes `byY_____` aggregate to decades instead of years. Another example is a multiplier of 6 provided to `by_m_____`. The function then aggregates all months of all first and all months of all second half years instead of all months of all years separately. This feature is supported by the following `TALFs` of the package:

- `byY_____`
- `byYm_____`
- `byYmdH__` (UTC and equivalent as well as all Etc/GMT time zones only)
- `byYmdHM_`
- `byYmdHMS`
- `by_m_____`
- `by___H__` (UTC and equivalent as well as all Etc/GMT time zones only)
- `by____M_`
- `by_____S`

### Ignore day saving time

`ignoreDST` tells a temporal aggregation level function if it is supposed to ignore day saving time while transforming the timestamps. This can be a desired feature for time series strictly following the position of the sun such as hydrological time series. Doing so ensures that diurnal variations are preserved by all means and all intervals are of the “correct” length, however, a possible limitation might be that the day saving time shift is invariably assumed to be one hour long. This feature requires that the periodicity of the time series was recognised and is supported by the following `TALFs` of the package:

- `byY_____`
- `byYQ_____`
- `byYm_____`
- `byYmd____`
- `by_Q_____`
- `by_m_____`
- `by___H__`

### See Also

`cols`, `getOption`

**Examples**

```

# new DTSg object
x <- DTSg$new(values = flow)

# linear interpolation of missing values
## R6 method
x$colapply(fun = interpolateLinear)$print()

## S3 method
print(colapply(x = x, fun = interpolateLinear))

# daily cumulative sums per month
## R6 method
x$colapply(
  fun = cumsum,
  helpers = FALSE,
  funby = byYm_____
)$print()

## S3 method
print(colapply(
  x = x,
  fun = cumsum,
  helpers = FALSE,
  funby = byYm_____
))

# calculate moving averages with the help of 'runner' (all four given
# approaches provide the same result with explicitly missing timestamps)
if (requireNamespace("runner", quietly = TRUE) &&
    packageVersion("runner") >= package_version("0.3.5")) {
  wrapper <- function(..., .helpers) {
    runner::runner(..., idx = .helpers[[".dateTime"]])
  }

  ## R6 method
  x$colapply(
    fun = runner::runner,
    f = mean,
    k = 5,
    lag = -2
  )$print()
  x$colapply(
    fun = wrapper,
    f = mean,
    k = "5 days",
    lag = "-2 days"
  )$print()
  x$colapply(
    fun = runner::runner,
    f = mean,
    k = "5 days",

```

```

    lag = "-2 days",
    idx = x$getCol(col = ".dateTime")
  )$print()
x$colapply(
  fun = runner::runner,
  f = mean,
  k = "5 days",
  lag = "-2 days",
  idx = x[".dateTime"]
)$print()

## S3 method
print(colapply(
  x = x,
  fun = runner::runner,
  f = mean,
  k = 5,
  lag = -2
))
print(colapply(
  x = x,
  fun = wrapper,
  f = mean,
  k = "5 days",
  lag = "-2 days"
))
print(colapply(
  x = x,
  fun = runner::runner,
  f = mean,
  k = "5 days",
  lag = "-2 days",
  idx = getCol(x = x, col = ".dateTime")
))
print(colapply(
  x = x,
  fun = runner::runner,
  f = mean,
  k = "5 days",
  lag = "-2 days",
  idx = x[".dateTime"]
))
}

# calculate rolling correlations somewhat inefficiently with the help of
# 'runner'
if (requireNamespace("runner", quietly = TRUE) &&
    packageVersion("runner") >= package_version("0.3.8")) {
  wrapper <- function(x, y, f, k, lag, ...) {
    runner::runner(
      cbind(x, y),
      f = function(x) f(x[, 1], x[, 2]),
      k = k,

```

```

        lag = lag
    )
}

## R6 method
x$colapply(
  fun = wrapper,
  y = x["flow"] + rnorm(length(x["flow"])),
  f = cor,
  k = 5,
  lag = -2
)$print()

## S3 method
print(colapply(
  x = x,
  fun = wrapper,
  y = x["flow"] + rnorm(length(x["flow"])),
  f = cor,
  k = 5,
  lag = -2
))
}

```

---

cols.DTSg

*Get column names*


---

## Description

Returns all column names of a [DTSg](#) object, those of certain [classes](#), [modes](#), [typeofs](#) and/or those matching a certain pattern only.

## Usage

```
## S3 method for class 'DTSg'
cols(x, class = NULL, pattern = NULL, mode = NULL, typeof = NULL, ...)
```

## Arguments

x	A <a href="#">DTSg</a> object (S3 method only).
class	An optional character vector matched to the most specific class (first element) of each column's <a href="#">class</a> vector. The "special class" ".numery" matches the <a href="#">integer</a> and <a href="#">numeric</a> classes.
pattern	An optional character string passed on to the <code>pattern</code> argument of <a href="#">grep</a> .
mode	An optional character vector matched to each column's <a href="#">mode</a> .
typeof	An optional character vector matched to each column's <a href="#">typeof</a> .
...	Further arguments passed on to <a href="#">grep</a> . The value argument is rejected.

**Value**

Returns a character vector.

**Examples**

```
# new DTSg object
x <- DTSg$new(values = flow)

# get names of numeric columns
## R6 method
x$cols(class = "numeric")

## 'names()' is a "hidden" R6 alias for 'cols()'
x$names(class = "numeric")

## S3 method
cols(x = x, class = "numeric")
```

---

DTSg

*DTSg class*


---

**Description**

The DTSg class is the working horse of the package. It is an `R6::R6Class` and offers an S3 interface in addition to its native R6 interface. In the usage sections of the documentation, unfortunately, only the usage of the S3 methods are displayed, however, the examples always show both ways of calling the respective method. Generally, they are very similar anyway. While the R6 interface always has the object first and the method is then selected with the help of the \$ operator, for instance, `x$cols()`, the S3 interface always has the method first and then the object as its first argument, for instance, `cols(x)`. An exception is the new method. It is not an S3 method, but an abused S4 constructor with the character string "DTSg" as its first argument. Regarding the R6 interface, the DTSg class generator has to be used to access the new method with the help of the \$ operator.

**Usage**

```
new(Class, values, ID = "", parameter = "", unit = "", variant = "",
     aggregated = FALSE, fast = getOption("DTSgFast"), swallow = FALSE,
     na.status = getOption("DTSgNA.status"), funbyApproach =
     getOption("DTSgFunbyApproach"))
```

**Arguments**

Class	A character string. Must be "DTSg" in order to create a DTSg object. Otherwise a different object may or may not be created (S4 constructor only).
-------	--

values	A <code>data.frame</code> or object inherited from class <code>data.frame</code> , e.g. <code>data.table::data.table</code> . Its first column must be of class <code>POSIXct</code> or coercible to it. It serves as the object's time index and is renamed to <code>.dateTime</code> .
ID	A character string specifying the ID (name) of the time series data object.
parameter	A character string specifying the parameter name of the time series data.
unit	A character string specifying the unit of the time series data.
variant	A character string specifying further metadata of the time series, for instance, "min" to point out that it is a time series of lower bound measurements.
aggregated	A logical specifying how the timestamps of the series have to be interpreted: as snap-shots (FALSE) or as periods between subsequent timestamps (TRUE).
fast	A logical specifying if all rows (FALSE) or only the first 1000 rows (TRUE) shall be used to check the object's integrity and for the automatic detection of the time series' periodicity.
swallow	A logical specifying if the object provided through the values argument shall be "swallowed" by the DTSg object, i.e. no copy of the data shall be made. This is generally more resource efficient, but only works when the provided object is a <code>data.table::data.table</code> . Be warned, however, that when the creation of the DTSg object fails for some reason, the first column of the provided <code>data.table::data.table</code> might have been coerced to <code>POSIXct</code> and keyed (see <code>data.table::setkey</code> for further information). Furthermore, all references to the "swallowed" <code>data.table::data.table</code> in the global (and only the global) environment are removed upon the successful creation of the DTSg object.
na.status	A character string. Either "explicit", which makes missing timestamps explicit according to the recognised periodicity, or "implicit", which removes timestamps with missing values on all value columns, or "undecided" for no such action. Please note that DTSg objects work best with explicitly missing values.
funbyApproach	A character string specifying the default flavour of TALFs used with the created DTSg object. Either "base", which utilises <code>as.POSIXct</code> , or "fasttime", which utilises <code>fasttime::fastPOSIXct</code> , or "RcppCCTZ", which utilises <code>RcppCCTZ::parseDatetime</code> as the main function for transforming timestamps. Custom approaches for user defined temporal aggregation level functions are also possible.

## Value

Returns a DTSg object.

## Methods

A DTSg object has the following methods:

- `aggregate`: See `aggregate` for further information.
- `alter`: See `alter` for further information.
- `clone`: See `clone` for further information.
- `colapply`: See `colapply` for further information.



- cols: See [cols](#) for further information.
- getCol: See [getCol](#) for further information.
- merge: See [merge](#) for further information.
- nas: See [nas](#) for further information.
- plot: See [plot](#) for further information.
- print: See [print](#) for further information.
- refresh: See [refresh](#) for further information.
- rollapply: See [rollapply](#) for further information.
- rowaggregate: See [rowaggregate](#) for further information.
- rowbind: See [rowbind](#) for further information.
- setColNames: See [setColNames](#) for further information.
- setCols: See [setCols](#) for further information.
- subset: See [subset](#) for further information.
- summary: See [summary](#) for further information.
- values: See [values](#) for further information.

## Fields

A DTSg object has the following fields or properties as they are often called. They are implemented through so called active bindings, which means that they can be accessed and actively set with the help of the `$` operator, for instance, `x$ID` gets the value of the ID field and `x$ID <- "River Flow"` sets its value. Please note that fields are always modified in place, i.e. no deep clone (copy) of the object is made beforehand. See [clone](#) for further information. Some of the fields are read-only though:

- aggregated: Same as the aggregated argument.
- fast: Same as the fast argument.
- funbyApproach: Same as the funbyApproach argument.
- ID: Same as the ID argument. It is used as the title of plots.
- na.status: Same as the na.status argument. When set, the missing values of the object are expanded or collapsed accordingly.
- parameter: Same as the parameter argument. It is used as the label of the primary axis of plots.
- periodicity: A [difftime](#) object for a regular and a character string for an irregular DTSg object describing its periodicity or containing "unrecognised" in case it could not be detected. When set, the periodicity of the time series is changed as specified. See the `by` argument of [alter](#) for further information.
- regular: A logical signalling if all lags in seconds between subsequent timestamps are the same (TRUE) or if some are different (FALSE). A, for instance, monthly time series is considered irregular in this sense (read-only).
- timestamps: An integer showing the total number of timestamps of the time series (read-only).

- `timezone`: A character string showing the time zone of the time series. When set, the series is converted to the specified time zone. Only names from [OlsonNames](#) are accepted.
- `unit`: Same as the `unit` argument. It is added to the label of the primary axis of plots when the `parameter` field is set.
- `variant`: Same as the `variant` argument. It is added to the label of the primary axis of plots when the `parameter` field is set.

The `parameter`, `unit` and `variant` fields are especially useful for time series of a single variable. For time series of multiple variables with differing units the functionality of the **units** package may pose a viable alternative.

## Options

The behaviour of DTSg objects can be customised with the help of the following option. See [options](#) for further information:

- *DTSgClone*: A logical specifying if DTSg objects are, by default, modified in place (FALSE) or if a deep clone (copy) shall be made beforehand (TRUE).
- *DTSgDeprecatedWarnings*: A logical specifying if warnings are displayed when calling deprecated features.
- *DTSgFast*: Default value for the `fast` argument.
- *DTSgFunbyApproach*: Default value for the `funbyApproach` argument.
- *DTSgNA.status*: Default value for the `na.status` argument.

## Note

Due to the [POSIXct](#) nature of the `.dateTime` column, the same sub-second accuracy, issues and limitations apply to DTSg objects. In order to prevent at least some of the possible precision issues, the lags between subsequent timestamps are rounded to microseconds during integrity checks. This corresponds to the maximum value allowed for `options("digits.secs")`. As a consequence, time series with a sub-second accuracy higher than a microsecond will never work.

## Examples

```
# new DTSg object
## R6 constructor
DTSg$new(
  values = flow,
  ID = "River Flow"
)

## abused S4 constructor
new(
  Class = "DTSg",
  values = flow,
  ID = "River Flow"
)
```

---

flow	<i>Daily river flows</i>
------	--------------------------

---

**Description**

A dataset containing a fictional time series of daily river flows with implicitly missing values.

**Usage**

```
flow
```

**Format**

A `data.table::data.table` with 2169 rows and two columns:

**date** A `POSIXct` vector ranging from the start of the year 2007 to the end of the year 2012.

**flow** A numeric vector with daily river flows in cubic metres per second.

---

<code>getCol.DTSg</code>	<i>Get column vector</i>
--------------------------	--------------------------

---

**Description**

Returns the values of a column of a `DTSg` object.

The extract operator (`[]`) acts as a shortcut for `getCol`.

**Usage**

```
## S3 method for class 'DTSg'
getCol(x, col = self$cols(class = "numeric")[1L], ...)
```

```
## S3 method for class 'DTSg'
x[...]
```

**Arguments**

<code>x</code>	A <code>DTSg</code> object ( <code>getCol</code> S3 method only).
<code>col</code>	A character string specifying a column name.
<code>...</code>	Arguments passed on to <code>getCol</code> (only used by the extract operator).

**Value**

Returns a vector or a `list` in case of a `list` column.

**See Also**[cols](#)**Examples**

```
# new DTsg object
x <- DTsg$new(values = flow)

# get the first ten values of the "flow" column
## R6 methods
x$getCol(col = "flow")[1:10]
x$`(`("flow"))[1:10]

## S3 methods
getCol(x = x, col = "flow")[1:10]
x["flow"][1:10]
```

---

interpolateLinear      *Linear interpolation*

---

**Description**

Linearly interpolates missing values of a numeric vector. For use with the [colapply](#) method of [DTsg](#) objects. Other uses are possible, but not recommended.

This [function](#) also serves as an example for writing user defined [functions](#) utilising one of the [lists](#) with helper data as handed over by some of the methods of [DTsg](#) objects.

**Usage**

```
interpolateLinear(.col, roll = Inf, rollends = TRUE, .helpers)
```

**Arguments**

<code>.col</code>	A numeric vector.
<code>roll</code>	A positive numeric specifying the maximum size of gaps whose missing values shall be interpolated. For time series with unrecognised periodicity it is interpreted in seconds and for time series with recognised periodicity it is multiplied with the maximum time difference between two subsequent time steps in seconds. Thus, for regular time series it is the number of time steps and for irregular it is an approximation of it.
<code>rollends</code>	A logical specifying if missing values at the start and end of the time series shall be filled. See <a href="#">data.table::data.table</a> for further information.
<code>.helpers</code>	A <a href="#">list</a> with helper data as handed over by <a href="#">colapply</a> . See <a href="#">colapply</a> for further information.

**Value**

Returns a numeric vector.

**Examples**

```
# new DTSg object
x <- DTSg$new(values = flow)

# linear interpolation of missing values
## R6 method
x$colapply(fun = interpolateLinear)$print()

## S3 method
print(colapply(x = x, fun = interpolateLinear))
```

---

merge.DTSg

*Merge two objects*


---

**Description**

Joins two [DTSg](#) objects based on their *.dateTime* column. Their time zones and aggregated fields must match.

**Usage**

```
## S3 method for class 'DTSg'
merge(x, y, ..., clone = getOption("DTSgClone"))
```

**Arguments**

x	A <a href="#">DTSg</a> object (S3 method only).
y	A <a href="#">DTSg</a> object or an object coercible to one. See <a href="#">new</a> for further information.
...	Further arguments passed on to <a href="#">data.table::merge</a> . As the by, by.x and by.y arguments can endanger the object's integrity, they are rejected.
clone	A logical specifying if the object shall be modified in place or if a deep clone (copy) shall be made beforehand.

**Value**

Returns a [DTSg](#) object.

**See Also**

[getOption](#)

**Examples**

```
# new DTSg object
x <- DTSg$new(values = flow)

# merge with 'data.table'
## R6 method
x$merge(
  y = flow,
  suffixes = c("_1", "_2")
)$print()

## S3 method
print(merge(
  x = x,
  y = flow,
  suffixes = c("_1", "_2")
))
```

nas.DTSg

*List missing values***Description**

Lists the missing values of selected columns of a [DTSg](#) object with recognised periodicity.

**Usage**

```
## S3 method for class 'DTSg'
nas(x, cols = self$cols(), ...)
```

**Arguments**

x	A <a href="#">DTSg</a> object (S3 method only).
cols	A character vector specifying the columns whose missing values shall be listed. Another possibility is a character string containing either comma separated column names, for example, "x,y,z", or the start and end column separated by a colon, for example, "x:z".
...	Not used (S3 method only).

**Value**

Returns a `data.table::data.table` with five columns:

- *.col*: the column name
- *.group*: the ID of the missing values group within each column
- *.from*: the first timestamp of the missing values group
- *.to*: the last timestamp of the missing values group
- *.n*: the number of missing values per group

**See Also**[cols](#)**Examples**

```
# new DTSg object
x <- DTSg$new(values = flow)

# list missing values
## R6 method
x$nas()

## S3 method
nas(x = x)
```

plot.DTSg

*Plot time series data***Description**

Displays an interactive plot of a [DTSg](#) object. This method requires **dygraphs** and **RColorBrewer** to be installed. Its main purpose is not to make pretty plots, but rather to offer a possibility to interactively explore time series data. The title of the plot and the label of its primary axis are automatically generated from the object's metadata (fields). See [DTSg](#) for further information.

**Usage**

```
## S3 method for class 'DTSg'
plot(
  x,
  from = first(self$values(reference = TRUE)[[".dateTime"]]),
  to = last(self$values(reference = TRUE)[[".dateTime"]]),
  cols = self$cols(class = "numeric"),
  secAxisCols = NULL,
  secAxisLabel = "",
  ...
)
```

**Arguments**

x	A <a href="#">DTSg</a> object (S3 method only).
from	A <a href="#">POSIXct</a> timestamp in the same time zone as the time series or a character string coercible to one. The data is plotted from this timestamp on.
to	A <a href="#">POSIXct</a> timestamp in the same time zone as the time series or a character string coercible to one. The data is plotted up to this timestamp.

cols	A character vector specifying the columns whose values shall be plotted. Another possibility is a character string containing either comma separated column names, for example, "x,y,z", or the start and end column separated by a colon, for example, "x:z".
secAxisCols	An optional character vector specifying the columns whose values shall be plotted on a secondary axis. Another possibility is a character string containing either comma separated column names, for example, "x,y,z", or the start and end column separated by a colon, for example, "x:z". Must be a subset of cols.
secAxisLabel	A character string specifying the label of the optional secondary axis.
...	Not used (S3 method only).

**Value**

Returns a [DTSg](#) object.

**See Also**

[cols](#)

**Examples**

```
# new DTSg object
x <- DTSg$new(values = flow)

# plot data
if (requireNamespace("dygraphs", quietly = TRUE) &&
    requireNamespace("RColorBrewer", quietly = TRUE)) {
  ## R6 method
  x$plot()

  ## S3 method
  plot(x = x)
}
```

---

print.DTSg

*Print object*

---

**Description**

Prints a [DTSg](#) object.

**Usage**

```
## S3 method for class 'DTSg'
print(x, ...)
```



**Arguments**

x                    A [DTSg](#) object (S3 method only).  
...                   Not used (S3 method only).

**Value**

Returns a [DTSg](#) object.

**Examples**

```
# new DTSg object
x <- DTSg$new(values = flow)

# print object
## R6 method
x$print()

## S3 method
print(x = x)
```

---

refresh.DTSg

*Object integrity*

---

**Description**

Checks the integrity of a [DTSg](#) object and tries to automatically (re-)detect its periodicity. Normally, there is no reason for a user to call this method. The only exception is stated in [values](#).

**Usage**

```
## S3 method for class 'DTSg'
refresh(x, ...)
```

**Arguments**

x                    A [DTSg](#) object (S3 method only).  
...                   Not used (S3 method only).

**Value**

Returns a [DTSg](#) object.

**Examples**

```
# new DTSg object
x <- DTSg$new(values = flow)

# check the object's integrity
## R6 method
x$refresh()

## S3 method
refresh(x = x)
```

---

rollapply.DTSg	<i>Rolling window function</i>
----------------	--------------------------------

---

**Description**

Applies an arbitrary function to a rolling window of selected columns of a [DTSg](#) object with recognised periodicity.

**Usage**

```
## S3 method for class 'DTSg'
rollapply(
  x,
  fun,
  ...,
  cols = self$cols(class = "numeric")[1L],
  before = 1L,
  after = before,
  weights = "inverseDistance",
  parameters = list(power = 1),
  resultCols = NULL,
  suffix = NULL,
  helpers = TRUE,
  memoryOverCPU = TRUE,
  clone = getOption("DTSgClone")
)
```

**Arguments**

x	A <a href="#">DTSg</a> object (S3 method only).
fun	A <a href="#">function</a> . Its return value must be of length one.
...	Further arguments passed on to fun.
cols	A character vector specifying the columns whose rolling window fun shall be applied to. Another possibility is a character string containing either comma separated column names, for example, "x,y,z", or the start and end column separated by a colon, for example, "x:z".

before	An integerish value specifying the size of the window in time steps before the “center” of the rolling window.
after	An integerish value specifying the size of the window in time steps after the “center” of the rolling window.
weights	A character string specifying the method applied to calculate the weights handed over to fun. These are useful for functions like <code>weighted.mean</code> . See corresponding section for further information.
parameters	A <code>list</code> specifying parameters for the weight calculation method. See corresponding section for further information.
resultCols	An optional character vector of the same length as <code>cols</code> specifying the column names for the return values of fun. Another possibility is a character string containing comma separated column names, for example, “x,y,z”. Non-existing columns are added and existing columns are overwritten. Columns are matched element-wise between <code>cols</code> and <code>resultCols</code> .
suffix	An optional character string. The return values of fun are added as new columns with names consisting of the columns specified in <code>cols</code> and this suffix. Existing columns are never overwritten. Only used when <code>resultCols</code> is not specified.
helpers	A logical specifying if helper data shall be handed over to fun. See corresponding section for further information.
memoryOverCPU	A logical specifying if memory usage shall be preferred over CPU usage for this method call. The former is generally faster for smaller windows and shorter time series, the latter for bigger windows and longer time series or might even be the only one which works depending on the available hardware.
clone	A logical specifying if the object shall be modified in place or if a deep clone (copy) shall be made beforehand.

## Value

Returns a `DTSg` object.

## Weights

Currently, only one method to calculate weights is supported: “inverseDistance”. The distance  $d$  of the “center” is one and each time step further away from the “center” adds one to it. So, for example, the distance of a timestamp three steps away from the “center” is four. Additionally, the calculation of the weights accepts a power parameter  $p$  as a named element of a `list` provided through the `parameters` argument:  $\frac{1}{d^p}$ .

## Helper data

In addition to the `...` argument, this method optionally hands over the weights as a numeric vector (`w` argument) and a `list` argument with helper data called `.helpers` to fun. This `list` contains the following elements:

- *before*: Same as the `before` argument.
- *after*: Same as the `after` argument.
- *windowSize*: Size of the rolling window (`before` + 1L + `after`).
- *centerIndex*: Index of the “center” of the rolling window (`before` + 1L).

**See Also**[cols](#), [getOption](#)**Examples**

```
# new DTsg object
x <- DTsg$new(values = flow)

# calculate a moving average
## R6 method
x$rollapply(
  fun = mean,
  na.rm = TRUE,
  before = 2,
  after = 2
)$print()

## S3 method
print(rollapply(
  x = x,
  fun = mean,
  na.rm = TRUE,
  before = 2,
  after = 2
))
```

---

rollback*Rollback of months*

---

**Description**

Generating regular sequences of time with the help of [seq.POSIXt](#) can have undesirable effects. This function “first advances the month without changing the day: if this results in an invalid day of the month, it is counted forward into the next month”. Monthly or yearly sequences starting at the end of a month with 30 or 31 days (or 29 in case of a leap year) therefore do not always fall on the end of shorter months. `rollback` fixes this by counting the days of affected months backwards again.

**Usage**

```
rollback(.dateTime, periodicity)
```

**Arguments**

`.dateTime` A [POSIXct](#) vector.

`periodicity` A character string specifying a multiple of month(s) or year(s). See [seq.POSIXt](#) for further information.

**Value**

Returns a [POSIXct](#) vector.

**Examples**

```
# rollback monthly time series
by <- "1 month"
rollback(
  .dateTime = seq(
    from = as.POSIXct("2000-01-31", tz = "UTC"),
    to = as.POSIXct("2000-12-31", tz = "UTC"),
    by = by
  ),
  periodicity = by
)
```

---

rowaggregate.DTSg	<i>Aggregate values row-wise</i>
-------------------	----------------------------------

---

**Description**

Applies one or more provided summary functions row-wise to selected columns of a [DTSg](#) object.

**Usage**

```
## S3 method for class 'DTSg'
rowaggregate(
  x,
  resultCols,
  fun,
  ...,
  cols = self$cols(class = "numeric"),
  clone = getOption("DTSgClone")
)
```

**Arguments**

x	A <a href="#">DTSg</a> object (S3 method only).
resultCols	A character vector either of length one (names of fun are appended in the case one or more functions are provided) or the same length as fun specifying the column names for the return values of fun.
fun	A summary function, (named) <a href="#">list</a> of summary functions or (named) character vector specifying summary functions applied row-wise to all the values of the specified cols. The return value(s) must be of length one. See corresponding section for further information.
...	Further arguments passed on to fun.

<code>cols</code>	A character vector specifying the columns to apply fun to. Another possibility is a character string containing either comma separated column names, for example, "x,y,z", or the start and end column separated by a colon, for example, "x:z".
<code>clone</code>	A logical specifying if the object shall be modified in place or if a deep clone (copy) shall be made beforehand.

**Value**

Returns a [DTSg](#) object.

**Summary functions**

Some examples for fun are as follows:

- `mean`
- `list(min = min, max = max)`
- `c(sd = "sd", var = "var")`

**See Also**

[cols](#), [getOption](#)

**Examples**

```
# new DTSg object
DT <- data.table::data.table(
  date = flow$date,
  flow1 = flow$flow - abs(rnorm(nrow(flow))),
  flow2 = flow$flow,
  flow3 = flow$flow + abs(rnorm(nrow(flow)))
)
x <- DTSg$new(values = DT)

# mean and standard deviation of multiple measurements per timestamp
## R6 method
x$rowaggregate(
  resultCols = "flow",
  fun = list(mean = mean, sd = sd)
)$print()

## 'raggregate()' is a "hidden" R6 alias for 'rowaggregate()'
x$raggregate(
  resultCols = "flow",
  fun = list(mean = mean, sd = sd)
)$print()

## S3 method
print(rowaggregate(
  x = x,
  resultCols = "flow",
```

```

    fun = list(mean = mean, sd = sd)
  ))

```

---

rowbind.DTSg	<i>Combine rows</i>
--------------	---------------------

---

## Description

Combines the rows of [DTSg](#) and other suitable objects.

## Usage

```

## S3 method for class 'DTSg'
rowbind(x, ..., clone = getOption("DTSgClone"))

```

## Arguments

x	A <a href="#">DTSg</a> object (S3 method only).
...	Any number of <a href="#">DTSg</a> objects or objects coercible to one (see <a href="#">new</a> for further information). <a href="#">lists</a> of such objects or a mixture of lists and non-lists are also accepted.
clone	A logical specifying if the object shall be modified in place or if a deep clone (copy) shall be made beforehand.

## Value

Returns a [DTSg](#) object.

## See Also

[cols](#), [getOption](#)

## Examples

```

# new DTSg object
x <- DTSg$new(values = flow[1:500, ])

# combine rows
## R6 method
x$rowbind(
  list(flow[1001:1500, ], DTSg$new(values = flow[501:1000, ])),
  flow[1501:.N, ]
)$print()

## 'rbind()' is a "hidden" R6 alias for 'rowbind()'
x$rbind(
  list(flow[1001:1500, ], DTSg$new(values = flow[501:1000, ])),
  flow[1501:.N, ]
)

```

```

)$print()

## S3 method
print(rowbind(
  x = x,
  list(flow[1001:1500, ], DTsg$new(values = flow[501:1000, ])),
  flow[1501:.N, ]
))

```

---

S3WrapperGenerator      *S3 wrapper method generator*

---

### Description

Generates S3 wrapper methods for public methods of R6ClassGenerators, but can also be used to generate “plain” function wrappers.

### Usage

```
S3WrapperGenerator(R6Method, self = "x", dots = TRUE)
```

### Arguments

R6Method	An <a href="#">expression</a> with or a public method ( <a href="#">function</a> ) of an R6ClassGenerator.
self	A character string specifying the name of the parameter, which will take the R6 object.
dots	A logical specifying if a <code>...</code> parameter shall be added as last parameter in case none already exists. This might be required for S3 generic/method consistency.

### Value

Returns an S3 method ([function](#)).

### See Also

[S3Methods](#), [R6::R6Class](#)

### Examples

```

# generate an S3 wrapper method for 'alter()' of 'DTsg'
alter.DTsg <- S3WrapperGenerator(
  R6Method = DTsg$public_methods$alter
)

```



---

setColNames.DTSg      *Set column names*

---

## Description

Changes the column names of [DTSg](#) objects.

## Usage

```
## S3 method for class 'DTSg'
setColNames(
  x,
  cols = self$cols(class = "numeric")[1L],
  values,
  clone = getOption("DTSgClone"),
  ...
)
```

## Arguments

x	A <a href="#">DTSg</a> object (S3 method only).
cols	A character vector specifying the columns whose names shall be set. Another possibility is a character string containing either comma separated column names, for example, "x,y,z", or the start and end column separated by a colon, for example, "x:z". The name of the <i>.dateTime</i> column cannot be changed.
values	A character vector of the same length as cols specifying the desired column names. Another possibility is a character string containing comma separated column names, for example, "x,y,z".
clone	A logical specifying if the object shall be modified in place or if a deep clone (copy) shall be made beforehand.
...	Not used (S3 method only).

## Value

Returns a [DTSg](#) object.

## See Also

[cols](#), [getOption](#)

## Examples

```
# new DTSg object
x <- DTSg$new(values = flow)

# rename column "flow" to "River Flow"
## R6 method
```

```

x$setColNames(
  cols = "flow",
  values = "River Flow"
)$print()

## 'setnames()' is a "hidden" R6 alias for 'setColNames()'
x$setnames(
  cols = "flow",
  values = "River Flow"
)$print()

## S3 method
print(setColNames(
  x = x,
  cols = "flow",
  values = "River Flow"
))

```

---

setCols.DTSg

*Set column values*


---

### Description

Changes the values of columns, adds columns to and/or removes columns from a [DTSg](#) object. The values can optionally be set for certain rows only.

### Usage

```

## S3 method for class 'DTSg'
setCols(
  x,
  i,
  cols = self$cols(class = "numeric")[1L],
  values,
  clone = getOption("DTSgClone"),
  ...
)

```

### Arguments

x	A <a href="#">DTSg</a> object (S3 method only).
i	An integerish vector indexing rows (positive numbers pick and negative numbers omit rows) or a filter expression accepted by the <code>i</code> argument of <a href="#">data.table::data.table</a> . Filter expressions can contain the special symbol <code>.N</code> .
cols	A character vector specifying the columns whose values shall be set. Another possibility is a character string containing comma separated column names, for example, "x,y,z". The values of the <code>.dateTime</code> column cannot be changed.

values	A vector, <a href="#">list</a> or list-like object (e.g. <code>data.table::data.table</code> ) of replacement and/or new values accepted by the value argument of <code>data.table</code> 's <code>data.table::set</code> function. NULL as a value removes a column.
clone	A logical specifying if the object shall be modified in place or if a deep clone (copy) shall be made beforehand.
...	Not used (S3 method only).

**Value**

Returns a [DTSg](#) object.

**See Also**

[cols](#), [getOption](#)

**Examples**

```
# new DTSg object
x <- DTSg$new(values = flow)

# cap river flows to 100
## R6 method
x$setCols(
  i = flow > 100,
  cols = "flow",
  values = 100
)$print()

## 'set()' is a "hidden" R6 alias for 'setCols()'
x$set(
  i = flow > 100,
  cols = "flow",
  values = 100
)$print()

## S3 method
print(setCols(
  x = x,
  i = flow > 100,
  cols = "flow",
  values = 100
))

# set measurement unit with the help of 'units'
if (requireNamespace("units", quietly = TRUE)) {
  ## R6 method
  x$setCols(
    cols = "flow",
    values = units::set_units(x["flow"], "m^3/s")
  )$print()
}
```

```

## S3 method
print(setCols(
  x = x,
  cols = "flow",
  values = units::set_units(x["flow"], "m^3/s")
))
}

```

subset.DTSg

*Subset time series data***Description**

Filters rows and/or selects columns of a [DTSg](#) object.

**Usage**

```

## S3 method for class 'DTSg'
subset(
  x,
  i,
  cols = self$cols(),
  funby = NULL,
  ignoreDST = FALSE,
  na.status = "implicit",
  clone = getOption("DTSgClone"),
  multiplier = 1L,
  funbyHelpers = NULL,
  funbyApproach = self$funbyApproach,
  ...
)

```

**Arguments**

x	A <a href="#">DTSg</a> object (S3 method only).
i	An integerish vector indexing rows (positive numbers pick and negative numbers omit rows) or a filter expression accepted by the <code>i</code> argument of <a href="#">data.table::data.table</a> . Filter expressions can contain the special symbol <code>.N</code> .
cols	A character vector specifying the columns to select. Another possibility is a character string containing either comma separated column names, for example, "x,y,z", or the start and end column separated by a colon, for example, "x:z". The <code>.dateTime</code> column is always selected and cannot be part of it.
funby	One of the temporal aggregation level functions described in <a href="#">TALFs</a> or a user defined temporal aggregation level function. Can be used to, for instance, select the last two observations of a certain temporal level. See corresponding section and examples for further information.

ignoreDST	A logical specifying if day saving time shall be ignored by funby. See corresponding section for further information.
na.status	A character string. Either "explicit", which makes missing timestamps explicit according to the recognised periodicity, or "implicit", which removes timestamps with missing values on all value columns. See corresponding section for further information.
clone	A logical specifying if the object shall be modified in place or if a deep clone (copy) shall be made beforehand.
multiplier	A positive integerish value "multiplying" the temporal aggregation level of certain TALFs. See corresponding section for further information.
funbyHelpers	An optional <a href="#">list</a> with helper data passed on to funby. See corresponding section for further information.
funbyApproach	A character string specifying the flavour of the applied temporal aggregation level function. Either "base", which utilises <code>as.POSIXct</code> , or "fasttime", which utilises <code>fasttime::fastPOSIXct</code> , or "RcppCCTZ", which utilises <code>RcppCCTZ::parseDatetime</code> as the main function for transforming timestamps.
...	Further arguments passed on to fun.

### Value

Returns a [DTSg](#) object.

### Status of missing values

Please note that filtering rows and having or making missing timestamps explicit equals to setting the values of all other timestamps to missing. The default value of `na.status` is therefore "implicit". To simply filter for a consecutive range of a [DTSg](#) object while leaving the `na.status` untouched, [alter](#) is probably the better choice.

### User defined TALFs, TALFs helper data and multiplier

User defined temporal aggregation level functions have to return a [POSIXct](#) vector of the same length as the time series and accept two arguments: a [POSIXct](#) vector as its first and a [list](#) with helper data as its second. The default elements of this [list](#) are as follows:

- *timezone*: Same as the [timezone](#) field.
- *ignoreDST*: Same as the `ignoreDST` argument.
- *periodicity*: Same as the [periodicity](#) field.
- *na.status*: Same as the `na.status` field.
- *multiplier*: Same as the `multiplier` argument.
- *funbyApproach*: Same as the `funbyApproach` argument.

Any additional element specified in the `funbyHelpers` argument is appended to the end of the helper data [list](#). In case `funbyHelpers` contains an *ignoreDST*, *multiplier* or *funbyApproach* element, it takes precedence over the respective method argument. *timezone*, *periodicity* and *na.status* elements are rejected, as they are always taken directly from the object.

The temporal aggregation level of certain [TALFs](#) can be adjusted with the help of the multiplier argument. A multiplier of 10, for example, makes [byY\\_\\_\\_\\_\\_](#) aggregate to decades instead of years. Another example is a multiplier of 6 provided to [by\\_m\\_\\_\\_\\_\\_](#). The function then aggregates all months of all first and all months of all second half years instead of all months of all years separately. This feature is supported by the following [TALFs](#) of the package:

- [byY\\_\\_\\_\\_\\_](#)
- [byYm\\_\\_\\_\\_\\_](#)
- [byYmdH\\_\\_](#) (UTC and equivalent as well as all Etc/GMT time zones only)
- [byYmdHM\\_](#)
- [byYmdHMS](#)
- [by\\_m\\_\\_\\_\\_\\_](#)
- [by\\_\\_\\_H\\_\\_](#) (UTC and equivalent as well as all Etc/GMT time zones only)
- [by\\_\\_\\_M\\_](#)
- [by\\_\\_\\_\\_\\_S](#)

### Ignore day saving time

`ignoreDST` tells a temporal aggregation level function if it is supposed to ignore day saving time while transforming the timestamps. This can be a desired feature for time series strictly following the position of the sun such as hydrological time series. Doing so ensures that diurnal variations are preserved by all means and all intervals are of the “correct” length, however, a possible limitation might be that the day saving time shift is invariably assumed to be one hour long. This feature requires that the periodicity of the time series was recognised and is supported by the following [TALFs](#) of the package:

- [byY\\_\\_\\_\\_\\_](#)
- [byYQ\\_\\_\\_\\_\\_](#)
- [byYm\\_\\_\\_\\_\\_](#)
- [byYmd\\_\\_\\_\\_\\_](#)
- [by\\_Q\\_\\_\\_\\_\\_](#)
- [by\\_m\\_\\_\\_\\_\\_](#)
- [by\\_\\_\\_H\\_\\_](#)

### See Also

[cols](#), [getOption](#)

### Examples

```
# new DTSg object
x <- DTSg$new(values = flow)

# filter for the first six observations
## R6 method
x$subset(i = 1:6)$print()
```

```
## S3 method
print(subset(x = x, i = 1:6))

# filter for the last two observations per year
## R6 method
x$subset(
  i = (.N - 1):.N,
  funby = function(x, ...) {data.table::year(x)}
)$print()

## S3 method
print(subset(
  x = x,
  i = (.N - 1):.N,
  funby = function(x, ...) {data.table::year(x)}
))
```

---

summary.DTSg

*Summarise time series data*

---

## Description

Calculates summary statistics of selected columns of a [DTSg](#) object.

## Usage

```
## S3 method for class 'DTSg'
summary(object, cols = self$cols(), ...)
```

## Arguments

object	A <a href="#">DTSg</a> object (S3 method only).
cols	A character vector specifying the columns whose values shall be summarised. Another possibility is a character string containing either comma separated column names, for example, "x,y,z", or the start and end column separated by a colon, for example, "x:z".
...	Further arguments passed on to <a href="#">summary.data.frame</a> .

## Value

Returns a [table](#).

## See Also

[cols](#)

## Examples

```
# new DTsg object
x <- DTsg$new(values = flow)

# calculate summary statistics
## R6 method
x$summary()

## S3 method
summary(object = x)
```

---

TALFs

*Temporal Aggregation Level Functions (TALFs)*

---

## Description

Simply hand over one of these functions to the `funby` argument of one of the methods of a [DTsg](#) object, which supports it. The method then does the rest of the work. See respective calling method for further information. Other uses are possible, but not recommended.

## Usage

```
byY____(.dateTime, .helpers)
byYQ____(.dateTime, .helpers)
byYm____(.dateTime, .helpers)
byYmd___(.dateTime, .helpers)
byYmdH__(.dateTime, .helpers)
byYmdHM_(.dateTime, .helpers)
byYmdHMS(.dateTime, .helpers)
by_____.dateTime, .helpers)
by_Q____(.dateTime, .helpers)
by_m____(.dateTime, .helpers)
by___H__(.dateTime, .helpers)
by___M_(.dateTime, .helpers)
```



```

by_____S(.dateTime, .helpers)
byFasttimeY_____(.dateTime, .helpers)
byFasttimeYQ_____(.dateTime, .helpers)
byFasttimeYm_____(.dateTime, .helpers)
byFasttimeYmd____(.dateTime, .helpers)
byFasttimeYmdH____(.dateTime, .helpers)
byFasttimeYmdHM____(.dateTime, .helpers)
byFasttimeYmdHMS____(.dateTime, .helpers)
byFasttime_____Q_____(.dateTime, .helpers)
byFasttime_____m_____(.dateTime, .helpers)
byFasttime_____H____(.dateTime, .helpers)
byFasttime_____M____(.dateTime, .helpers)
byFasttime_____S____(.dateTime, .helpers)

```

### Arguments

<code>.dateTime</code>	A <a href="#">POSIXct</a> vector.
<code>.helpers</code>	A <a href="#">list</a> with helper data as handed over by methods of <a href="#">DTSG</a> objects, which support the <code>funby</code> argument.

### Value

All functions return a [POSIXct](#) vector with timestamps corresponding to the function's temporal aggregation level.

### Families and flavours

There are two families of temporal aggregation level functions. The one family truncates timestamps (truncating family), the other extracts a certain part of them (extracting family). Each family comes in three flavours: the first relies solely on base R, the second utilises [fasttime::fastPOSIXct](#) of **fasttime** and the third [RcppCCTZ::parseDatetime](#) of **RcppCCTZ**.

The **fasttime** flavour works with UTC and equivalent as well as all Etc/GMT time zones only (execute `grep("^(Etc/)?(UCT|UTC)$|^^(Etc/)?GMT(\\+|-)?0?$", OlsonNames(), ignore.case`

= TRUE, value = TRUE) for a full list of supported time zones) and is limited to timestamps between the years 1970 and 2199, but generally is the fastest for the extracting family of functions. For time zones other than UTC and equivalent the **RcppCCTZ** flavour generally is the fastest.

Use the `funbyApproach` argument of the respective calling method in order to specify the utilised flavour.

The truncating family sets timestamps to the lowest possible point in time of the corresponding temporal aggregation level:

- `byY_____` truncates to year, e.g. `2000-11-11 11:11:11.1` becomes `2000-01-01 00:00:00.0`
- `byYQ_____` truncates to quarter, e.g. `2000-11-11 11:11:11.1` becomes `2000-10-01 00:00:00.0`
- `byYm_____` truncates to month, e.g. `2000-11-11 11:11:11.1` becomes `2000-11-01 00:00:00.0`
- `byYmd_____` truncates to day, e.g. `2000-11-11 11:11:11.1` becomes `2000-11-11 00:00:00.0`
- `byYmdH_____` truncates to hour, e.g. `2000-11-11 11:11:11.1` becomes `2000-11-11 11:00:00.0`
- `byYmdHM_____` truncates to minute, e.g. `2000-11-11 11:11:11.1` becomes `2000-11-11 11:11:00.0`
- `byYmdHMS_____` truncates to second, e.g. `2000-11-11 11:11:11.1` becomes `2000-11-11 11:11:11.0`

By convention, the extracting family sets the year to 2199 and extracts a certain part of timestamps:

- `by_____` extracts nothing, i.e. all timestamps become `2199-01-01 00:00:00.0`
- `by_Q_____` extracts the quarters, e.g. `2000-11-11 11:11:11.1` becomes `2199-10-01 00:00:00.0`
- `by_m_____` extracts the months, e.g. `2000-11-11 11:11:11.1` becomes `2199-11-01 00:00:00.0`
- `by___H_____` extracts the hours, e.g. `2000-11-11 11:11:11.1` becomes `2199-01-01 11:00:00.0`
- `by___M_____` extracts the minutes, e.g. `2000-11-11 11:11:11.1` becomes `2199-01-01 00:11:00.0`
- `by_____S` extracts the seconds, e.g. `2000-11-11 11:11:11.1` becomes `2199-01-01 00:00:11.0`

Please note that the `byFasttime*` versions are deprecated.

## See Also

[aggregate](#), [colapply](#), [subset](#)

---

values.DTSg

*Get values*

---

## Description

Returns the values of a [DTSg](#) object.

## Usage

```
## S3 method for class 'DTSg'
values(
  x,
  reference = FALSE,
  drop = FALSE,
  class = c("data.table", "data.frame"),
  ...
)
```

**Arguments**

x	A <a href="#">DTSg</a> object (S3 method only).
reference	A logical specifying if a copy of the values or a reference to the values shall be returned. See corresponding section for further information.
drop	A logical specifying if the object and all references to it shall be removed from the global (and only the global) environment after successfully returning its values. This feature allows for a resource efficient destruction of a <a href="#">DTSg</a> object while preserving its values.
class	A character string specifying the class of the returned values. "data.frame" only works when either a copy of the values is returned or the object is dropped.
...	Not used (S3 method only).

**Value**

Returns a [data.table::data.table](#), a reference to a [data.table::data.table](#) or a [data.frame](#).

**Reference to the values**

A reference to the values of a [DTSg](#) object can be used to modify them in place. This includes the *.dateTime* column, which serves as the object's time index. Modifying this column can therefore endanger the object's integrity. In case needs to do so ever arise, [refresh](#) should be called immediately afterwards in order to check the object's integrity.

**Note**

The original name of the *.dateTime* column is restored when not returned as a reference or when dropped.

**Examples**

```
# new DTSg object
x <- DTSg$new(values = flow)

# get values
## R6 method
x$values()

## S3 method
values(x = x)
```

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