

Package ‘imputeTS’

August 4, 2020

Version 3.1

Date 2020-08-04

Title Time Series Missing Value Imputation

Description Imputation (replacement) of missing values in univariate time series. Offers several imputation functions and missing data plots. Available imputation algorithms include: 'Mean', 'LOCF', 'Interpolation', 'Moving Average', 'Seasonal Decomposition', 'Kalman Smoothing on Structural Time Series models', 'Kalman Smoothing on ARIMA models'. Published in Moritz and Bartz-Beielstein (2017) <doi: 10.32614/RJ-2017-009>.

Author Steffen Moritz [aut, cre, cph] (<<https://orcid.org/0000-0002-0085-1804>>), Sebastian Gatscha [aut], Earo Wang [ctb] (<<https://orcid.org/0000-0001-6448-5260>>)

Maintainer Steffen Moritz <steffen.moritz10@gmail.com>

LazyData yes

Type Package

ByteCompile TRUE

BugReports <https://github.com/SteffenMoritz/imputeTS/issues>

URL <https://github.com/SteffenMoritz/imputeTS>,
<https://steffenmoritz.github.io/imputeTS/>

Repository CRAN

Depends R (>= 3.0.1)

Imports utils, stats, grDevices, ggplot2, ggtext, stinepack, forecast, magrittr, Rcpp

Suggests testthat, R.rsp, knitr, zoo, timeSeries, tis, xts, tibble, tsibble, rmarkdown

License GPL-3

VignetteBuilder R.rsp, knitr, rmarkdown

RoxygenNote 7.1.0

LinkingTo Rcpp

Encoding UTF-8

NeedsCompilation yes

Date/Publication 2020-08-04 21:50:17 UTC

R topics documented:

ggplot_na_distribution	2
ggplot_na_gapsize	5
ggplot_na_imputations	8
ggplot_na_intervals	11
na_interpolation	14
na_kalman	15
na_locf	17
na_ma	19
na_mean	20
na_random	22
na_remove	23
na_replace	24
na_seadec	25
na_seasplit	26
statsNA	28
tsAirgap	29
tsAirgapComplete	30
tsHeating	31
tsHeatingComplete	32
tsNH4	33
tsNH4Complete	34
Index	35

ggplot_na_distribution

Visualize the Distribution of Missing Values

Description

Visualize the distribution of missing values within a time series.

Usage

```
ggplot_na_distribution(
  x,
  x_axis_labels = NULL,
  color_points = "steelblue",
  color_lines = "steelblue2",
  color_missing = "indianred",
  color_missing_border = "indianred",
  alpha_missing = 0.5,
  title = "Distribution of Missing Values",
  subtitle = "Time Series with highlighted missing regions",
  xlab = "Time",
  ylab = "Value",
  shape_points = 20,
  size_points = 2.5,
  theme = ggplot2::theme_linedraw()
)
```

Arguments

<code>x</code>	Numeric Vector (vector) or Time Series (ts) object containing NAs. This is the only mandatory parameter - all other parameters are only needed for adjusting the plot appearance.
<code>x_axis_labels</code>	For adding specific x-axis labels. Takes a vector of Date or POSIXct objects as an input (needs the same length as <code>x</code>) . The Default (NULL) uses the observation numbers as x-axis tick labels.
<code>color_points</code>	Color for the Symbols/Points.
<code>color_lines</code>	Color for the Lines.
<code>color_missing</code>	Color used for highlighting the time spans with NA values.
<code>color_missing_border</code>	Color used as border for time spans with NA values.
<code>alpha_missing</code>	Transparency value used for <code>color_missing</code> .
<code>title</code>	Title of the Plot (NULL for deactivating title).
<code>subtitle</code>	Subtitle of the Plot (NULL for deactivating subtitle).
<code>xlab</code>	Label for x-Axis.
<code>ylab</code>	Label for y-Axis.
<code>shape_points</code>	Symbol to use for the Observations/Points. See https://ggplot2.tidyverse.org/articles/ggplot2-specs.html as reference.
<code>size_points</code>	Size of Symbols/Points.
<code>theme</code>	Set a Theme for ggplot2. Default is <code>ggplot2::theme_linedraw()</code> . (theme_linedraw)

Details

This function visualizes the distribution of missing values within a time series. If a value is NA, the background is colored differently. This gives a good overview of where most missing values occur.

The only really needed parameter for this function is `x` (the univariate time series that shall be visualized). All other parameters are solely for altering the appearance of the plot.

As long as the input is univariate and numeric the function also takes `data.frame`, `tibble`, `tsibble`, `zoo`, `xts` as an input.

The plot can be adjusted to your needs via the function parameters. Additionally for more complex adjustments, the output can also be adjusted via `ggplot2` syntax. This is possible, since the output of the function is a `ggplot2` object. Also take a look at the Examples to see how adjustments are made.

For very long time series it might happen, that the plot gets too crowded and overplotting issues occur. In this case the `ggplot_na_intervals` plotting function can provide a more condensed overview.

Author(s)

Steffen Moritz, Sebastian Gatscha

See Also

[ggplot_na_intervals](#), [ggplot_na_gapsize](#), [ggplot_na_imputations](#)

Examples

```
# Example 1: Visualize the missing values in x
x <- stats::ts(c(1:11, 4:9, NA, NA, NA, 11:15, 7:15, 15:6, NA, NA, 2:5, 3:7))
ggplot_na_distribution(x)

# Example 2: Visualize the missing values in tsAirgap time series
ggplot_na_distribution(tsAirgap)

# Example 3: Same as example 1, just written with pipe operator
x <- ts(c(1:11, 4:9, NA, NA, NA, 11:15, 7:15, 15:6, NA, NA, 2:5, 3:7))
x %>% ggplot_na_distribution()

# Example 4: Visualize NAs in tsAirgap - different color for points
# Plot adjustments via ggplot_na_distribution function parameters
ggplot_na_distribution(tsAirgap, color_points = "grey")

# Example 5: Visualize NAs in tsAirgap - different theme
# Plot adjustments via ggplot_na_distribution function parameters
ggplot_na_distribution(tsAirgap, theme = ggplot2::theme_classic())

# Example 6: Visualize NAs in tsAirgap - title, subtitle in center
# Plot adjustments via ggplot2 syntax
ggplot_na_distribution(tsAirgap) +
  ggplot2::theme(plot.title = ggplot2::element_text(hjust = 0.5)) +
  ggplot2::theme(plot.subtitle = ggplot2::element_text(hjust = 0.5))

# Example 7: Visualize NAs in tsAirgap - title in center, no subtitle
# Plot adjustments via ggplot2 syntax and function parameters
ggplot_na_distribution(tsAirgap, subtitle = NULL) +
  ggplot2::theme(plot.title = ggplot2::element_text(hjust = 0.5))
```

```
# Example 8: Visualize NAs in tsAirgap - x-axis texts with angle
# Plot adjustments via ggplot2 syntax and function parameters
ggplot_na_distribution(tsAirgap, color_points = "grey") +
  ggplot2::theme(axis.text.x = ggplot2::element_text(angle = 60, hjust = 1))
```

ggplot_na_gapsize *Visualize Occurrences of NA gap sizes*

Description

Visualize the Number of Occurrences for existing NA Gap Sizes (NAs in a row) in a Time Series

Usage

```
ggplot_na_gapsize(
  x,
  limit = 10,
  include_total = TRUE,
  ranked_by = "occurrence",
  color_occurrence = "indianred",
  color_total = "steelblue",
  title = "Occurrence of gap sizes",
  subtitle = "Gap sizes (NAs in a row) ordered by most common",
  xlab = NULL,
  ylab = "Number occurrence",
  legend = TRUE,
  orientation = "horizontal",
  label_occurrence = "Number occurrence gapsize",
  label_total = "Resulting NAs for gapsize",
  theme = ggplot2::theme_linedraw()
)
```

Arguments

- | | |
|---------------|--|
| x | Numeric Vector (vector) or Time Series (ts) object containing NAs. This is the only mandatory parameter - all other parameters are only needed for adjusting the plot appearance. |
| limit | Specifies how many of the most common gap sizes are shown in the plot. Default is 10. So only the 10 most often occurring gapsizes will be shown. If more or all present gap sizes should be displayed, the limit needs to be increased. Since this might add a lot of additional data, having parameter orientation set to 'horizontal' avoids overlaps in the axis labels. |
| include_total | When set to TRUE the total NA count for a gapsize is included in the plot (total = number occurrence x gap size). E.g. if a gapsize of 3 occurs 10 times, this means this gap size makes up for 30 NAs in total. This can be a good indicator of the overall impact of a gapsize. |

<code>ranked_by</code>	Should the results be sorted according to the number of occurrence or total resulting NAs for a gap size. Total resulting NAs are calculated by (total = number occurrence x gap size). <ul style="list-style-type: none"> "occurrence" - Sorting by 'number of occurrence' of a gap size "total" - Sorting by 'total resulting NAs' of a gap size The default setting is "occurrence".
<code>color_occurrence</code>	Defines the Color for the Bars of 'number of occurrence'.
<code>color_total</code>	Defines the color for the bars of 'total resulting NAs'.
<code>title</code>	Title of the Plot.
<code>subtitle</code>	Subtitle of the Plot.
<code>xlab</code>	Label for x-Axis.
<code>ylab</code>	Label for y-Axis.
<code>legend</code>	If TRUE a legend is added at the bottom.
<code>orientation</code>	Can be either 'vertical' or 'horizontal'. Defines if the bars are plotted vertically or horizontally. For large amounts of different gap sizes horizontal illustration is favorable (also see parameter <code>limit</code>).
<code>label_occurrence</code>	Defines the label assigned to 'number of occurrence' in the legend.
<code>label_total</code>	Defines the label assigned to 'total resulting NAs' in the legend.
<code>theme</code>	Set a Theme for ggplot2. Default is <code>ggplot2::theme_linedraw()</code> . (theme_linedraw)

Details

This plotting function can be used to visualize the length of the NA gaps (NAs in a row) in a time series. It shows a ranking of which gap sizes occur most often. This ranking can be ordered by the number occurrence of the gap sizes or by total resulting NAs for this gap size (occurrence * gap length). A NA-gap of 3 occurring 10 times means 30 total resulting NAs.

A resulting plot can for example be described like this: a 2 NA-gap (2 NAs in a row) occurred 27 times, a 9 NA-gap (9 NAs in a row) occurred 11 times, a 27 NA-gap (27 NAs in a row) occurred 1 times, ...

The only really needed parameter for this function is `x` (the univariate time series with NAs that shall be visualized). All other parameters are solely for altering the appearance of the plot.

As long as the input is univariate and numeric the function also takes `data.frame`, `tibble`, `tsibble`, `zoo`, `xts` as an input.

The plot can be adjusted to your needs via the function parameters. Additionally for more complex adjustments, the output can also be adjusted via `ggplot2` syntax. This is possible, since the output of the function is a `ggplot2` object. Also take a look at the Examples to see how adjustments are made.

Value

The output is a `ggplot2` object that can be further adjusted by using the `ggplot` syntax

Author(s)

Steffen Moritz, Sebastian Gatscha

See Also[ggplot_na_distribution](#), [ggplot_na_intervals](#), [ggplot_na_imputations](#)**Examples**

```
# Example 1: Visualize the top gap sizes in tsNH4 (top 10 by default)
ggplot_na_gapsize(tsNH4)

# Example 2: Visualize the top gap sizes in tsAirgap - horizontal bars
ggplot_na_gapsize(tsAirgap, orientation = "vertical")

# Example 3: Same as example 1, just written with pipe operator
tsNH4 %>% ggplot_na_gapsize()

# Example 4: Visualize the top 20 gap sizes in tsNH4
ggplot_na_gapsize(tsNH4, limit = 20)

# Example 5: Visualize top gap sizes in tsNH4 without showing total NAs
ggplot_na_gapsize(tsNH4, limit = 20, include_total = FALSE)

# Example 6: Visualize top gap sizes in tsNH4 but ordered by total NAs
# (total = occurrence * gap length)
ggplot_na_gapsize(tsNH4, limit = 20, ranked_by = "total")

# Example 7: Visualize top gap sizes in tsNH4 - different theme
# Plot adjustments via ggplot_na_gapsize function parameters
ggplot_na_gapsize(tsNH4, theme = ggplot2::theme_classic())

# Example 8: Visualize top gap sizes in tsNH4 - title, subtitle in center
# Plot adjustments via ggplot2 syntax
ggplot_na_gapsize(tsNH4) +
  ggplot2::theme(plot.title = ggplot2::element_text(hjust = 0.5)) +
  ggplot2::theme(plot.subtitle = ggplot2::element_text(hjust = 0.5))

# Example 9: Visualize top gap sizes in tsNH4 - title in center, no subtitle
# Plot adjustments via ggplot2 syntax and function parameters
ggplot_na_gapsize(tsNH4, subtitle = NULL) +
  ggplot2::theme(plot.title = ggplot2::element_text(hjust = 0.5))

# Example 10: Top gap sizes in tsNH4 - legend on the right and color change
# Plot adjustments via ggplot2 syntax and function parameters
ggplot_na_gapsize(tsNH4, color_total = "grey") +
  ggplot2::theme(legend.position = "right")
```

`ggplot_na_imputations` *Visualize Imputed Values*

Description

Visualize the imputed values in a time series.

Usage

```
ggplot_na_imputations(  
  x_with_na,  
  x_with_imputations,  
  x_with_truth = NULL,  
  x_axis_labels = NULL,  
  title = "Imputed Values",  
  subtitle = "Visualization of missing value replacements",  
  xlab = "Time",  
  ylab = "Value",  
  color_points = "steelblue",  
  color_imputations = "indianred",  
  color_truth = "seagreen3",  
  color_lines = "lightslategray",  
  shape_points = 16,  
  shape_imputations = 18,  
  shape_truth = 16,  
  size_points = 1.5,  
  size_imputations = 2.5,  
  size_truth = 1.5,  
  size_lines = 0.5,  
  linetype = "solid",  
  connect_na = TRUE,  
  legend = TRUE,  
  legend_size = 5,  
  label_known = "known values",  
  label_imputations = "imputed values",  
  label_truth = "ground truth",  
  theme = ggplot2::theme_linedraw()  
)
```

Arguments

`x_with_na` Numeric Vector or Time Series (**ts**) object with NAs before imputation. This parameter and `x_with_imputation` have to be set. The rest of the parameters are mostly needed for adjusting the plot appearance.

<code>x_with_imputations</code>	Numeric Vector or Time Series (ts) object with NAs replaced by imputed values. This parameter and <code>x_with_imputation</code> have to be set. The rest of the parameters are mostly needed for adjusting the plot appearance.
<code>x_with_truth</code>	Numeric Vector or Time Series (ts) object with the real values (optional parameter). If the ground truth is known (e.g. in experiments where the missing values were artificially added) it can be displayed in the plot with this parameter. Default is NULL (ground truth not known).
<code>x_axis_labels</code>	For adding specific x-axis labels. Takes a vector of Date or POSIXct objects as an input (needs the same length as <code>x_with_na</code>). The Default (NULL) uses the observation numbers as x-axis tick labels.
<code>title</code>	Title of the Plot.
<code>subtitle</code>	Subtitle of the Plot.
<code>xlab</code>	Label for x-Axis.
<code>ylab</code>	Label for y-Axis.
<code>color_points</code>	Color for the Symbols/Points of the non-NA Observations.
<code>color_imputations</code>	Color for the Symbols/Points of the Imputed Values.
<code>color_truth</code>	Color for the Symbols/Points of the NA value Ground Truth (only relevant when <code>x_with_truth</code> available).
<code>color_lines</code>	Color for the Lines connecting the Observations/Points.
<code>shape_points</code>	Shape for the Symbols/Points of the non-NA observations. See https://ggplot2.tidyverse.org/articles/ggplot2-specs.html as reference.
<code>shape_imputations</code>	Shape for the Symbols/Points of the imputed values. See https://ggplot2.tidyverse.org/articles/ggplot2-specs.html as reference.
<code>shape_truth</code>	Shape for the Symbols/Points of the NA value Ground Truth (only relevant when <code>x_with_truth</code> available).
<code>size_points</code>	Size for the Symbols/Points of the non-NA Observations.
<code>size_imputations</code>	Size for the Symbols/Points of the Imputed Values.
<code>size_truth</code>	Size for the Symbols/Points of the NA value Ground Truth (only relevant when <code>x_with_truth</code> available).
<code>size_lines</code>	Size for the Lines connecting the Observations/Points.
<code>linetype</code>	Linetype for the Lines connecting the Observations/Points.
<code>connect_na</code>	If TRUE the Imputations are connected to the non-NA observations in the plot. Otherwise there are no connecting lines between symbols in NA areas.
<code>legend</code>	If TRUE a Legend is added at the bottom.
<code>legend_size</code>	Size of the Symbols used in the Legend.
<code>label_known</code>	Legend label for the non-NA Observations.
<code>label_imputations</code>	Legend label for the Imputed Values.
<code>label_truth</code>	Legend label for the Ground Truth of the NA values.
<code>theme</code>	Set a Theme for ggplot2. Default is <code>ggplot2::theme_linedraw()</code> . (theme_linedraw)

Details

This plot can be used, to visualize imputed values for a time series. Imputed values (filled NA gaps) are shown in a different color than the other values. If real values (ground truth) for the NA gaps are known, they can be optionally added in a different color.

The only really needed parameters for this function are `x_with_na` (the time series with NAs before imputation) and `x_with_imputations` (the time series without NAs after imputation). All other parameters are mostly for altering the appearance of the plot.

As long as the input is univariate and numeric the function also takes `data.frame`, `tibble`, `tsibble`, `zoo`, `xts` as an input.

The plot can be adjusted to your needs via the function parameters. Additionally for more complex adjustments, the output can also be adjusted via `ggplot2` syntax. This is possible, since the output of the function is a `ggplot2` object. Also take a look at the Examples to see how adjustments are made.

Author(s)

Steffen Moritz, Sebastian Gatscha

See Also

[ggplot_na_distribution](#), [ggplot_na_intervals](#), [ggplot_na_gapsize](#)

Examples

```
# Example 1: Visualize imputation by na.mean
imp_mean <- na_mean(tsAirgap)
ggplot_na_imputations(tsAirgap, imp_mean)

# Example 2: Visualize imputation by na_locf and added ground truth
imp_locf <- na_locf(tsAirgap)
ggplot_na_imputations(x_with_na = tsAirgap,
                      x_with_imputations = imp_locf,
                      x_with_truth = tsAirgapComplete
                      )

# Example 3: Visualize imputation by na_kalman
imp_kalman <- na_kalman(tsAirgap)
ggplot_na_imputations(x_with_na = tsAirgap, x_with_imputations = imp_kalman)

# Example 4: Same as example 1, just written with pipe operator
tsAirgap %>%
  na_mean() %>%
  ggplot_na_imputations(x_with_na = tsAirgap)

# Example 5: Visualize imputation by na_seadec - different color for imputed points
# Plot adjustments via ggplot_na_imputations function parameters
imp_seadec <- na_seadec(tsAirgap)
```

```

ggplot_na_imputations(x_with_na = tsAirgap,
                      x_with_imputations = imp_seadec,
                      color_imputations = "gold")

# Example 6: Visualize imputation - different theme, point size imputations
# Plot adjustments via ggplot_na_imputations function parameters
imp_seadec <- na_seadec(tsAirgap)
ggplot_na_imputations(x_with_na = tsAirgap,
                      x_with_imputations = imp_seadec,
                      theme = ggplot2::theme_classic(),
                      size_imputations = 5)

# Example 7: Visualize imputation - title, subtitle in center
# Plot adjustments via ggplot2 syntax
imp_seadec <- na_seadec(tsAirgap)
ggplot_na_imputations(x_with_na = tsAirgap, x_with_imputations = imp_seadec) +
  ggplot2::theme(plot.title = ggplot2::element_text(hjust = 0.5)) +
  ggplot2::theme(plot.subtitle = ggplot2::element_text(hjust = 0.5))

# Example 8: Visualize imputation - title in center, no subtitle
# Plot adjustments via ggplot2 syntax and function parameters
imp_mean <- na_mean(tsAirgap)
ggplot_na_imputations(x_with_na = tsAirgap,
                      x_with_imputations = imp_mean,
                      subtitle = NULL) +
  ggplot2::theme(plot.title = ggplot2::element_text(hjust = 0.5))

```

ggplot_na_intervals *Visualize Missing Values per Interval*

Description

Visualization of missing values in barplot form. Especially useful when looking at specific intervals and for time series with a lot of observations.

Usage

```

ggplot_na_intervals(
  x,
  number_intervals = NULL,
  interval_size = NULL,
  measure = "percent",
  color_missing = "indianred2",
  color_existing = "steelblue",
  alpha_missing = 0.8,

```

```

alpha_existing = 0.3,
title = "Missing Values per Interval",
subtitle = "Amount of NA and non-NA for successive intervals",
xlab = "Time Lapse (Interval Size: XX)",
ylab = NULL,
color_border = "white",
theme = ggplot2::theme_linedraw()
)

```

Arguments

x	Numeric Vector (vector) or Time Series (ts) object containing NAs. This is the only mandatory parameter - all other parameters are only needed for adjusting the plot appearance.
number_intervals	Defines the number of bins to be created. Default number of intervals (denoted by NULL) is calculated by nclass.Sturges using Sturges' formula. If the interval_size parameter is set to a value different to NULL this parameter is ignored.
interval_size	Defines how many observations should be in one bin/interval. The required number of overall bins is afterwards calculated automatically. If used this parameter overwrites the number_intervals parameter. For a very long time series be sure to make the interval_size not extremely small, otherwise because of overplotting issues nothing can be seen until you also increase the plot width.
measure	Whether the NA / non-NA ratio should be given as percent or absolute numbers. <ul style="list-style-type: none"> • "percent" - for percentages • "count" - for absolute numbers of NAs
color_missing	Color for the amount of missing values.
color_existing	Color for the amount of existing values.
alpha_missing	Alpha (transparency) value for the missing values.
alpha_existing	Alpha (transparency) value for the existing values.
title	Title of the Plot (NULL for deactivating title).
subtitle	Subtitle of the Plot (NULL for deactivating subtitle).
xlab	Label for x-Axis. Automatically set to the current interval size, if no custom text is chosen.
ylab	Label for y-Axis. As default (NULL), the axis is automatically set to either 'Percent' or 'Count' dependent on the settings of parameter measure.
color_border	Color for the small borders between the intervals/bins. Default is 'white'.
theme	Set a Theme for ggplot2. Default is ggplot2::theme_linedraw(). (theme_linedraw)

Details

This function visualizes the distribution of missing values within a time series. In comparison to the [ggplot_na_distribution](#) function this is not done by plotting each observation of the time

series separately. Instead observations for time intervals are represented as intervals/bins of multiple values. For these intervals information about the amount of missing values are shown. This has the advantage, that also for large time series a plot which is easy to overview can be created.

The only really needed parameter for this function is `x` (the univariate time series that shall be visualized). All other parameters are solely for altering the appearance of the plot.

As long as the input is univariate and numeric the function also takes `data.frame`, `tibble`, `tsibble`, `zoo`, `xts` as an input.

The plot can be adjusted to your needs via the function parameters. Additionally for more complex adjustments, the output can also be adjusted via `ggplot2` syntax. This is possible, since the output of the function is a `ggplot2` object. Also take a look at the Examples to see how adjustments are made.

Author(s)

Steffen Moritz, Sebastian Gatscha

See Also

[ggplot_na_distribution](#), [ggplot_na_gapsize](#), [ggplot_na_imputations](#)

Examples

```
# Example 1: Visualize the missing values in tsNH4 time series
ggplot_na_intervals(tsNH4)

# Example 2: Visualize the missing values in tsHeating time series
ggplot_na_intervals(tsHeating)

# Example 3: Same as example 1, just written with pipe operator
tsNH4 %>% ggplot_na_intervals()

# Example 4: Visualize NAs in tsNH4 - exactly 8 intervals
ggplot_na_intervals(tsNH4, number_intervals = 8)

# Example 5: Visualize NAs in tsNH4 - 300 observations per interval
ggplot_na_intervals(tsNH4, interval_size = 300)

# Example 6: Visualize NAs in tsAirgap - different color for NAs
# Plot adjustments via ggplot_na_intervals function parameters
ggplot_na_intervals(tsAirgap, color_missing = "pink")

# Example 7: Visualize NAs in tsNH4 - different theme
# Plot adjustments via ggplot_na_intervals function parameters
ggplot_na_intervals(tsNH4, theme = ggplot2::theme_classic())

# Example 8: Visualize NAs in tsAirgap - title, subtitle in center
# Plot adjustments via ggplot2 syntax
ggplot_na_intervals(tsAirgap) +
  ggplot2::theme(plot.title = ggplot2::element_text(hjust = 0.5)) +
  ggplot2::theme(plot.subtitle = ggtext::element_markdown(hjust = 0.5))

# Example 9: Visualize NAs in tsAirgap - title in center, no subtitle
```

```
# Plot adjustments via ggplot2 syntax and function parameters
ggplot_na_intervals(tsAirgap, subtitle = NULL) +
  ggplot2::theme(plot.title = ggplot2::element_text(hjust = 0.5))

# Example 10: Visualize NAs in tsAirgap - x-axis texts with angle
# Plot adjustments via ggplot2 syntax and function parameters
ggplot_na_intervals(tsAirgap, color_missing = "grey") +
  ggplot2::theme(axis.text.x = ggplot2::element_text(angle = 60, hjust = 1))
```

na_interpolation *Missing Value Imputation by Interpolation*

Description

Uses either linear, spline or stineman interpolation to replace missing values.

Usage

```
na_interpolation(x, option = "linear", maxgap = Inf, ...)
```

Arguments

x	Numeric Vector (vector) or Time Series (ts) object in which missing values shall be replaced
option	Algorithm to be used. Accepts the following input: <ul style="list-style-type: none"> • "linear" - for linear interpolation using approx • "spline" - for spline interpolation using spline • "stine" - for Stineman interpolation using stinterp
maxgap	Maximum number of successive NAs to still perform imputation on. Default setting is to replace all NAs without restrictions. With this option set, consecutive NAs runs, that are longer than 'maxgap' will be left NA. This option mostly makes sense if you want to treat long runs of NA afterwards separately.
...	Additional parameters to be passed through to approx or spline interpolation functions

Details

Missing values get replaced by values of a [approx](#), [spline](#) or [stinterp](#) interpolation.

Value

Vector ([vector](#)) or Time Series ([ts](#)) object (dependent on given input at parameter x)

Author(s)

Steffen Moritz

References

Johannesson, Tomas, et al. (2015). "Package stinepack".

See Also

[na_kalman](#), [na_locf](#), [na_ma](#), [na_mean](#), [na_random](#), [na_replace](#), [na_seadec](#), [na_seasplit](#)

Examples

```
# Prerequisite: Create Time series with missing values
x <- ts(c(2, 3, 4, 5, 6, NA, 7, 8))

# Example 1: Perform linear interpolation
na_interpolation(x)

# Example 2: Perform spline interpolation
na_interpolation(x, option = "spline")

# Example 3: Perform stine interpolation
na_interpolation(x, option = "stine")

# Example 4: Same as example 1, just written with pipe operator
x %>% na_interpolation()

# Example 5: Same as example 2, just written with pipe operator
x %>% na_interpolation(option = "spline")
```

na_kalman	<i>Missing Value Imputation by Kalman Smoothing and State Space Models</i>
-----------	--

Description

Uses Kalman Smoothing on structural time series models (or on the state space representation of an arima model) for imputation.

Usage

```
na_kalman(x, model = "StructTS", smooth = TRUE, nit = -1, maxgap = Inf, ...)
```

Arguments

x	Numeric Vector (vector) or Time Series (ts) object in which missing values shall be replaced
model	Model to be used. With this parameter the State Space Model (on which KalmanSmooth is performed) can be chosen. Accepts the following input: <ul style="list-style-type: none"> "auto.arima" - For using the state space representation of arima model (using auto.arima)

- "StructTS" - For using a structural model fitted by maximum likelihood (using [StructTS](#))

For both `auto.arima` and `StructTS` additional parameters for model building can be given with the `...` parameter

Additionally it is also possible to use a user created state space model (See code Example 5). This state space model could for example be obtained from another R package for structural time series modeling. Furthermore providing the state space representation of a arima model from `arima` is also possible. But it is important to note, that user created state space models must meet the requirements specified under `KalmanLike`. This means the user supplied state space model has to be in form of a list with at least components T, Z, h, V, a, P, Pn. (more details under `KalmanLike`)

<code>smooth</code>	if TRUE - <code>KalmanSmooth</code> is used for estimation, if FALSE - <code>KalmanRun</code> is used. Since <code>KalmanRun</code> is often considered extrapolation <code>KalmanSmooth</code> is usually the better choice for imputation.
<code>nit</code>	Parameter from Kalman Filtering (see <code>KalmanLike</code>). Usually no need to change from default.
<code>maxgap</code>	Maximum number of successive NAs to still perform imputation on. Default setting is to replace all NAs without restrictions. With this option set, consecutive NAs runs, that are longer than 'maxgap' will be left NA. This option mostly makes sense if you want to treat long runs of NA afterwards separately.
<code>...</code>	Additional parameters to be passed through to the functions that build the State Space Models (<code>StructTS</code> or <code>auto.arima</code>).

Details

The `KalmanSmoother` used in this function is `KalmanSmooth`. It operates either on a Basic Structural Model obtained by `StructTS` or the state space representation of a ARMA model obtained by `auto.arima`.

For an detailed explanation of Kalman Filtering and Space Space Models the following literature is a good starting point:

- *G. Welch, G. Bishop, An Introduction to the Kalman Filter. SIGGRAPH 2001 Course 8, 1995*
- *Harvey, Andrew C. Forecasting, structural time series models and the Kalman filter. Cambridge university press, 1990*
- *Grewal, Mohinder S. Kalman filtering. Springer Berlin Heidelberg, 2011*

Value

Vector (`vector`) or Time Series (`ts`) object (dependent on given input at parameter x)

Author(s)

Steffen Moritz

References

Hyndman RJ and Khandakar Y (2008). "Automatic time series forecasting: the forecast package for R". Journal of Statistical Software, 26(3).

See Also

[na_interpolation](#), [na_locf](#), [na_ma](#), [na_mean](#), [na_random](#), [na_replace](#), [na_seadec](#), [na_seasplit](#)

Examples

```
# Example 1: Perform imputation with KalmanSmoother and state space representation of arima model
na_kalman(tsAirgap)

# Example 2: Perform imputation with KalmanRun and state space representation of arima model
na_kalman(tsAirgap, smooth = FALSE)

# Example 3: Perform imputation with KalmanSmooth and StructTS model
na_kalman(tsAirgap, model = "StructTS", smooth = TRUE)

# Example 4: Perform imputation with KalmanSmooth and StructTS model with additional parameters
na_kalman(tsAirgap, model = "StructTS", smooth = TRUE, type = "trend")

# Example 5: Perform imputation with KalmanSmooth and user created model
usermodel <- arima(tsAirgap, order = c(1, 0, 1))$model
na_kalman(tsAirgap, model = usermodel)

# Example 6: Same as example 1, just written with pipe operator
tsAirgap %>% na_kalman()
```

na_locf

Missing Value Imputation by Last Observation Carried Forward

Description

Replaces each missing value with the most recent present value prior to it (Last Observation Carried Forward- LOCF). Optionally this can also be done starting from the back of the series (Next Observation Carried Backward - NOCB).

Usage

```
na_locf(x, option = "locf", na_remaining = "rev", maxgap = Inf)
```

Arguments

x	Numeric Vector (vector) or Time Series (ts) object in which missing values shall be replaced
option	Algorithm to be used. Accepts the following input:

	<ul style="list-style-type: none"> • "locf" - for Last Observation Carried Forward • "nocb" - for Next Observation Carried Backward
na_remaining	Method to be used for remaining NAs. <ul style="list-style-type: none"> • "keep" - to return the series with NAs • "rm" - to remove remaining NAs • "mean" - to replace remaining NAs by overall mean • "rev" - to perform nocb / locf from the reverse direction
maxgap	Maximum number of successive NAs to still perform imputation on. Default setting is to replace all NAs without restrictions. With this option set, consecutive NAs runs, that are longer than 'maxgap' will be left NA. This option mostly makes sense if you want to treat long runs of NA afterwards separately.

Details

Replaces each missing value with the most recent present value prior to it (Last Observation Carried Forward- LOCF). This can also be done from the reverse direction -starting from the back (Next Observation Carried Backward - NOCB). Both options have the issue, that NAs at the beginning (or for nocb at the end) of the time series cannot be imputed (since there is no last value to be carried forward present yet). In this case there are remaining NAs in the imputed time series. Since this only concerns very few values at the beginning of the series, na_remaining offers some quick solutions to get a series without NAs back.

Value

Vector ([vector](#)) or Time Series ([ts](#)) object (dependent on given input at parameter x)

Author(s)

Steffen Moritz

See Also

[na_interpolation](#), [na_kalman](#), [na_ma](#), [na_mean](#), [na_random](#), [na_replace](#), [na_seadec](#), [na_seasplit](#)

Examples

```
# Prerequisite: Create Time series with missing values
x <- ts(c(NA, 3, 4, 5, 6, NA, 7, 8))

# Example 1: Perform LOCF
na_locf(x)

# Example 2: Perform NOCF
na_locf(x, option = "nocb")

# Example 3: Perform LOCF and remove remaining NAs
na_locf(x, na_remaining = "rm")

# Example 4: Same as example 1, just written with pipe operator
x %>% na_locf()
```

na_ma

*Missing Value Imputation by Weighted Moving Average***Description**

Missing value replacement by weighted moving average. Uses semi-adaptive window size to ensure all NAs are replaced.

Usage

```
na_ma(x, k = 4, weighting = "exponential", maxgap = Inf)
```

Arguments

x	Numeric Vector (vector) or Time Series (ts) object in which missing values shall be replaced
k	integer width of the moving average window. Expands to both sides of the center element e.g. k=2 means 4 observations (2 left, 2 right) are taken into account. If all observations in the current window are NA, the window size is automatically increased until there are at least 2 non-NA values present.
weighting	Weighting to be used. Accepts the following input: <ul style="list-style-type: none"> • "simple" - Simple Moving Average (SMA) • "linear" - Linear Weighted Moving Average (LWMA) • "exponential" - Exponential Weighted Moving Average (EWMA)
maxgap	Maximum number of successive NAs to still perform imputation on. Default setting is to replace all NAs without restrictions. With this option set, consecutive NAs runs, that are longer than 'maxgap' will be left NA. This option mostly makes sense if you want to treat long runs of NA afterwards separately.

Details

In this function missing values get replaced by moving average values. Moving Averages are also sometimes referred to as "moving mean", "rolling mean", "rolling average" or "running average".

The mean in this implementation taken from an equal number of observations on either side of a central value. This means for an NA value at position i of a time series, the observations $i-1, i+1$ and $i+1, i+2$ (assuming a window size of $k=2$) are used to calculate the mean.

Since it can in case of long NA gaps also occur, that all values next to the central value are also NA, the algorithm has a semi-adaptive window size. Whenever there are less than 2 non-NA values in the complete window available, the window size is incrementally increased, till at least 2 non-NA values are there. In all other cases the algorithm sticks to the pre-set window size.

There are options for using Simple Moving Average (SMA), Linear Weighted Moving Average (LWMA) and Exponential Weighted Moving Average (EWMA).

SMA: all observations in the window are equally weighted for calculating the mean.

LWMA: weights decrease in arithmetical progression. The observations directly next to a central value i , have weight $1/2$, the observations one further away ($i-2, i+2$) have weight $1/3$, the next ($i-3, i+3$) have weight $1/4$, ...

EWMA: uses weighting factors which decrease exponentially. The observations directly next to a central value i , have weight $1/2^1$, the observations one further away ($i-2, i+2$) have weight $1/2^2$, the next ($i-3, i+3$) have weight $1/2^3$, ...

Value

Vector ([vector](#)) or Time Series ([ts](#)) object (dependent on given input at parameter x)

Author(s)

Steffen Moritz

See Also

[na_interpolation](#), [na_kalman](#), [na_locf](#), [na_mean](#), [na_random](#), [na_replace](#), [na_seadec](#), [na_seasplit](#)

Examples

```
# Example 1: Perform imputation with simple moving average
na_ma(tsAirgap, weighting = "simple")

# Example 2: Perform imputation with exponential weighted moving average
na_ma(tsAirgap)

# Example 3: Perform imputation with exponential weighted moving average, window size 6
na_ma(tsAirgap, k = 6)

# Example 4: Same as example 1, just written with pipe operator
tsAirgap %>% na_ma(weighting = "simple")
```

na_mean

Missing Value Imputation by Mean Value

Description

Missing value replacement by mean values. Different means like median, mean, mode possible.

Usage

```
na_mean(x, option = "mean", maxgap = Inf)
```

Arguments

x	Numeric Vector (vector) or Time Series (ts) object in which missing values shall be replaced
option	Algorithm to be used. Accepts the following input: <ul style="list-style-type: none">• "mean" - take the mean for imputation (default)• "median" - take the median for imputation• "mode" - take the mode for imputation• "harmonic" - take the harmonic mean• "geometric" - take the geometric mean
maxgap	Maximum number of successive NAs to still perform imputation on. Default setting is to replace all NAs without restrictions. With this option set, consecutive NAs runs, that are longer than 'maxgap' will be left NA. This option mostly makes sense if you want to treat long runs of NA afterwards separately.

Details

Missing values get replaced by overall mean values. The function calculates the mean, median or mode over all the non-NA values and replaces all NAs with this value. Option 'mode' replaces NAs with the most frequent value in the time series. If two or more values occur equally frequent, the function imputes with the lower value. That's why 'mode' is not the best option for decimal values.

Value

Vector ([vector](#)) or Time Series ([ts](#)) object (dependent on given input at parameter x)

Author(s)

Steffen Moritz

See Also

[na_interpolation](#), [na_kalman](#), [na_locf](#), [na_ma](#), [na_random](#), [na_replace](#), [na_seadec](#), [na_seasplit](#)

Examples

```
# Prerequisite: Create Time series with missing values
x <- ts(c(2, 3, 4, 5, 6, NA, 7, 8))

# Example 1: Perform imputation with the overall mean
na_mean(x)

# Example 2: Perform imputation with overall median
na_mean(x, option = "median")

# Example 3: Same as example 1, just written with pipe operator
x %>% na_mean()
```

`na_random`*Missing Value Imputation by Random Sample*

Description

Replaces each missing value by drawing a random sample between two given bounds.

Usage

```
na_random(x, lower_bound = NULL, upper_bound = NULL, maxgap = Inf)
```

Arguments

<code>x</code>	Numeric Vector (vector) or Time Series (ts) object in which missing values shall be replaced
<code>lower_bound</code>	Lower bound for the random samples. If nothing or NULL is set <code>min(x)</code> will be used.
<code>upper_bound</code>	Upper bound for the random samples. If nothing or NULL is set <code>max(x)</code> will be used.
<code>maxgap</code>	Maximum number of successive NAs to still perform imputation on. Default setting is to replace all NAs without restrictions. With this option set, consecutive NAs runs, that are longer than 'maxgap' will be left NA. This option mostly makes sense if you want to treat long runs of NA afterwards separately.

Details

Replaces each missing value by drawing a random sample between two given bounds. The default bounds are the minimum and the maximum value in the non-NAs from the time series. Function uses [runif](#) function to get the random values.

Value

Vector ([vector](#)) or Time Series ([ts](#)) object (dependent on given input at parameter `x`)

Author(s)

Steffen Moritz

See Also

[na_interpolation](#), [na_kalman](#), [na_locf](#), [na_ma](#), [na_mean](#), [na_replace](#), [na_seadec](#), [na_seasplit](#)

Examples

```
# Prerequisite: Create Time series with missing values
x <- ts(c(2, 3, NA, 5, 6, NA, 7, 8))

# Example 1: Replace all NAs by random values that are between min and max of the input time series
na_random(x)

# Example 2: Replace all NAs by random values between 1 and 10
na_random(x, lower_bound = 1, upper_bound = 10)

# Example 3: Same as example 1, just written with pipe operator
x %>% na_random()
```

na_remove	<i>Remove Missing Values</i>
-----------	------------------------------

Description

Removes all missing values from a time series.

Usage

```
na_remove(x)
```

Arguments

x Numeric Vector ([vector](#)) or Time Series ([ts](#)) object in which missing values shall be replaced

Details

Removes all missing values from a input time series. This shortens the time series by the number of missing values in the series. Should be handled with care, because this can affect the seasonality of the time series. Seasonal patterns might be destroyed. Independent from the input, this function only returns a vector. (the time information of a resulting time series object wouldn't be correct any more).

Value

Vector ([vector](#))

Author(s)

Steffen Moritz

See Also

[na_interpolation](#), [na_kalman](#), [na_locf](#), [na_ma](#), [na_mean](#), [na_random](#), [na_replace](#), [na_seadec](#), [na_seasplit](#)

Examples

```
# Example 1: Remove all NAs
# Create Time series with missing values
x <- ts(c(2, 3, NA, 5, 6, NA, 7, 8))

# Example 1: Remove all NAs
na_remove(x)

# Example 2: Remove all NAs in tsAirgap
na_remove(tsAirgap)

# Example 3: Same as example 1, just written with pipe operator
x %>% na_remove()
```

na_replace

Replace Missing Values by a Defined Value

Description

Replaces all missing values with a given value.

Usage

```
na_replace(x, fill = 0, maxgap = Inf)
```

Arguments

x	Numeric Vector (vector) or Time Series (ts) object in which missing values shall be replaced
fill	Value used to replace the missing values
maxgap	Maximum number of successive NAs to still perform imputation on. Default setting is to replace all NAs without restrictions. With this option set, consecutive NAs runs, that are longer than 'maxgap' will be left NA. This option mostly makes sense if you want to treat long runs of NA afterwards separately.

Value

Vector ([vector](#)) or Time Series ([ts](#)) object (dependent on given input at parameter x)

Author(s)

Steffen Moritz

See Also

[na_interpolation](#), [na_kalman](#), [na_locf](#), [na_ma](#), [na_mean](#), [na_random](#), [na_seadec](#), [na_seasplit](#)

Examples

```
# Prerequisite: Create Time series with missing values
x <- ts(c(2, 3, NA, 5, 6, NA, 7, 8))

# Example 1: Replace all NAs with 3.5
na_replace(x, fill = 3.5)

# Example 2: Replace all NAs with 0
na_replace(x, fill = 0)

# Example 3: Same as example 1, just written with pipe operator
x %>% na_replace(fill = 3.5)
```

na_seadec

*Seasonally Decomposed Missing Value Imputation***Description**

Removes the seasonal component from the time series, performs imputation on the deseasonalized series and afterwards adds the seasonal component again.

Usage

```
na_seadec(
  x,
  algorithm = "interpolation",
  find_frequency = FALSE,
  maxgap = Inf,
  ...
)
```

Arguments

x	Numeric Vector (vector) or Time Series (ts) object in which missing values shall be replaced
algorithm	Algorithm to be used after decomposition. Accepts the following input: <ul style="list-style-type: none"> • "interpolation" - Imputation by Interpolation • "locf" - Imputation by Last Observation Carried Forward • "mean" - Imputation by Mean Value • "random" - Imputation by Random Sample • "kalman" - Imputation by Kalman Smoothing and State Space Models • "ma" - Imputation by Weighted Moving Average
find_frequency	If TRUE the algorithm will try to estimate the frequency of the time-series automatically.

maxgap Maximum number of successive NAs to still perform imputation on. Default setting is to replace all NAs without restrictions. With this option set, consecutive NAs runs, that are longer than 'maxgap' will be left NA. This option mostly makes sense if you want to treat long runs of NA afterwards separately.

... Additional parameters for these algorithms that can be passed through. Look at [na_interpolation](#), [na_locf](#), [na_random](#), [na_mean](#) for parameter options.

Value

Vector ([vector](#)) or Time Series ([ts](#)) object (dependent on given input at parameter x)

Author(s)

Steffen Moritz

See Also

[na_interpolation](#), [na_kalman](#), [na_locf](#), [na_ma](#), [na_mean](#), [na_random](#), [na_replace](#), [na_seasplit](#)

Examples

```
# Example 1: Perform seasonal imputation using algorithm = "interpolation"
na_seadec(tsAirgap, algorithm = "interpolation")

# Example 2: Perform seasonal imputation using algorithm = "mean"
na_seadec(tsAirgap, algorithm = "mean")

# Example 3: Same as example 1, just written with pipe operator
tsAirgap %>% na_seadec(algorithm = "interpolation")
```

na_seasplit

Seasonally Splitted Missing Value Imputation

Description

Splits the times series into seasons and afterwards performs imputation separately for each of the resulting time series datasets (each containing the data for one specific season).

Usage

```
na_seasplit(
  x,
  algorithm = "interpolation",
  find_frequency = FALSE,
  maxgap = Inf,
  ...
)
```

Arguments

x	Numeric Vector (vector) or Time Series (ts) object in which missing values shall be replaced
algorithm	Algorithm to be used after splits. Accepts the following input: <ul style="list-style-type: none"> • "interpolation" - Imputation by Interpolation • "locf" - Imputation by Last Observation Carried Forward • "mean" - Imputation by Mean Value • "random" - Imputation by Random Sample • "kalman" - Imputation by Kalman Smoothing and State Space Models • "ma" - Imputation by Weighted Moving Average
find_frequency	If TRUE the algorithm will try to estimate the frequency of the time-series automatically.
maxgap	Maximum number of successive NAs to still perform imputation on. Default setting is to replace all NAs without restrictions. With this option set, consecutive NAs runs, that are longer than 'maxgap' will be left NA. This option mostly makes sense if you want to treat long runs of NA afterwards separately.
...	Additional parameters for these algorithms that can be passed through. Look at na_interpolation , na_locf , na_random , na_mean for parameter options.

Value

Vector ([vector](#)) or Time Series ([ts](#)) object (dependent on given input at parameter x)

Author(s)

Steffen Moritz

See Also

[na_interpolation](#), [na_kalman](#), [na_locf](#), [na_ma](#), [na_mean](#), [na_random](#), [na_replace](#), [na_seadec](#)

Examples

```
# Example 1: Perform seasonal splitted imputation using algorithm = "interpolation"
na_seasplit(tsAirgap, algorithm = "interpolation")

# Example 2: Perform seasonal splitted imputation using algorithm = "mean"
na_seasplit(tsAirgap, algorithm = "mean")

# Example 3: Same as example 1, just written with pipe operator
tsAirgap %>% na_seasplit(algorithm = "interpolation")
```

statsNA *Print Statistics about Missing Values*

Description

Print summary stats about the distribution of missing values in a univariate time series.

Usage

```
statsNA(x, bins = 4, print_only = TRUE)
```

Arguments

x	Numeric Vector (vector) or Time Series (ts) object containing NAs
bins	Split number for bin stats. Number of bins the time series gets divided into. For each bin information about amount/percentage of missing values is printed. Default value is 4 - what means stats about the 1st,2nd,3rd,4th quarter of the time series are shown.
print_only	Choose if the function Prints or Returns. For print_only = TRUE the function has no return value and just prints out missing value stats. If print_only is changed to FALSE, nothing is printed and the function returns a list. Print gives a little bit more information, since the returned list does not include "Stats for Bins" and "overview NA series"

Details

Prints the following information about the missing values in the time series:

- "Length of time series" - Number of observations in the time series (including NAs)
- "Number of Missing Values" - Number of missing values in the time series
- "Percentage of Missing Values" - Percentage of missing values in the time series
- "Number of Gaps" - Number of NA gaps (consisting of one or more consecutive NAs) in the time series
- "Average Gap Size" - Average size of consecutive NAs for the NA gaps in the time series
- "Stats for Bins" - Number/percentage of missing values for the split into bins
- "Longest NA gap" - Longest series of consecutive missing values (NAs in a row) in the time series
- "Most frequent gap size" - Most frequent occurring series of missing values in the time series
- "Gap size accounting for most NAs" - The series of consecutive missing values that accounts for most missing values overall in the time series
- "Overview NA series" - Overview about how often each series of consecutive missing values occurs. Series occurring 0 times are skipped

It is furthermore, important to note, that you are able to choose whether the function returns a list or prints the information only. (see description of parameter "print_only")

Value

A [list](#) containing the stats. Beware: Function gives only a return value if `print_only = FALSE`.

Author(s)

Steffen Moritz

See Also

[ggplot_na_distribution](#), [ggplot_na_intervals](#), [ggplot_na_gapsize](#)

Examples

```
# Example 1: Print stats about the missing data in tsNH4
statsNA(tsNH4)

# Example 2: Return list with stats about the missing data in tsAirgap
statsNA(tsAirgap, print_only = FALSE)

# Example 3: Same as example 1, just written with pipe operator
tsNH4 %>% statsNA()
```

tsAirgap

Time series of monthly airline passengers (with NAs)

Description

Monthly totals of international airline passengers, 1949 to 1960. This time series contains missing values. In the package included is also the [tsAirgapComplete](#) time series providing the true values for the missing values.

Usage

```
tsAirgap
```

Format

Time Series ([ts](#)) with 144 rows including 13 NAs.

Details

The dataset originates from Box & Jenkins (see citation) and is a commonly used example in time series analysis literature.

Its characteristics (strong trend, strong seasonal behavior) make it also a great example for time series imputation. Thus the version with inserted NA gaps was created under the name `tsAirgap`.

In order to use this series for comparing imputation algorithm results, there are two time series provided. One series without missing values, which can be used as ground truth. Another series with NAs, on which the imputation algorithms can be applied.

There are the two time series:

- tsAirgap - The time series with NAs.
- tsAirgapComplete - Time series without NAs.

Source

Box, G. E. P., Jenkins, G. M., Reinsel, G. C. and Ljung, G. M. (2015). *Time series analysis: forecasting and control. Fifth Edition.* John Wiley & Sons.

See Also

[tsHeating](#), [tsNH4](#)

tsAirgapComplete	<i>Time series of monthly airline passengers (complete)</i>
------------------	---

Description

Monthly totals of international airline passengers, 1949 to 1960. This time series provides the truth for the missing values of the [tsAirgap](#) time series. Thus it is identical to the tsAirgap time series except that no value is missing.

Usage

```
tsAirgapComplete
```

Format

Time Series ([ts](#)) with 144 rows.

Details

The dataset originates from Box & Jenkins (see citation) and is a commonly used example in time series analysis literature.

Its characteristics (strong trend, strong seasonal behavior) make it also a great example for time series imputation. Thus the version with inserted NA gaps was created under the name tsAirgap.

In order to use this series for comparing imputation algorithm results, there are two time series provided. One series without missing values, which can be used as ground truth. Another series with NAs, on which the imputation algorithms can be applied.

There are the two time series:

- tsAirgap - The time series with NAs.
- tsAirgapComplete - Time series without NAs.

Source

Box, G. E. P., Jenkins, G. M., Reinsel, G. C. and Ljung, G. M. (2015). *Time series analysis: forecasting and control. Fifth Edition.* John Wiley & Sons.

See Also[tsHeating](#), [tsNH4](#)

`tsHeating`*Time series of a heating systems supply temperature (with NAs)*

Description

Time series of a heating systems supply temperature. Measured from 18.11.2013 - 05:12:00 to 13.01.2015 - 15:08:00 in 1 minute steps. This time series contains missing values. In the package included is also the [tsHeatingComplete](#) time series providing the true values for the missing values.

Usage`tsHeating`**Format**

Time Series ([ts](#)) with 606837 rows including 57391 NAs.

Details

The time series originates from the GECCO Industrial Challenge 2015. This Challenge was about "Recovering missing information in heating system operating data". Goal was to impute missing values in heating system sensor data as accurate as possible. (<http://www.spotseven.de/gecco-challenge/gecco-challenge-2015/>)

In order to use this series for comparing imputation algorithm results, there are two time series provided. One series without missing values, which can be used as ground truth. Another series with NAs, on which the imputation algorithms can be applied. The NAs thereby were inserted according to patterns found in similar time series.

There are the two time series:

- `tsHeating` - The time series with NAs.
- `tsHeatingComplete` - Time series without NAs.

Source

<http://www.spotseven.de/gecco-challenge/gecco-challenge-2015/>

See Also[tsAirgap](#), [tsNH4](#)

tsHeatingComplete	<i>Time series of a heating systems supply temperature (complete)</i>
-------------------	---

Description

Time series of a heating systems supply temperature. Measured from 18.11.2013 - 05:12:00 to 13.01.2015 - 15:08:00 in 1 minute steps. This time series provides the truth for the missing values of the [tsHeating](#) time series. Thus it is identical to the heating time series except that no value is missing.

Usage

```
tsHeatingComplete
```

Format

Time Series ([ts](#)) with 606837 rows.

Details

The time series originates from the GECCO Industrial Challenge 2015. This Challenge was about "Recovering missing information in heating system operating data". Goal was to impute missing values in heating system sensor data as accurate as possible. (<http://www.spotseven.de/gecco-challenge/gecco-challenge-2015/>)

In order to use this series for comparing imputation algorithm results, there are two time series provided. One series without missing values, which can be used as ground truth. Another series with NAs, on which the imputation algorithms can be applied. The NAs thereby were inserted according to patterns found in similar time series.

There are the two time series:

- [tsHeating](#) - The time series with NAs.
- [tsHeatingComplete](#) - Time series without NAs.

Source

<http://www.spotseven.de/gecco-challenge/gecco-challenge-2015/>

See Also

[tsAirgap](#), [tsNH4](#)

tsNH4	<i>Time series of NH4 concentration in a wastewater system (with NAs)</i>
-------	---

Description

Time series of NH4 concentration in a wastewater system. Measured from 30.11.2010 - 16:10 to 01.01.2011 - 6:40 in 10 minute steps. This time series contains missing values. In the package included is also the [tsNH4Complete](#) time series providing the true values for the missing values.

Usage

tsNH4

Format

Time Series ([ts](#)) with 4552 rows including 883 NAs.

Details

The time series is derived from the dataset of the GECCO Industrial Challenge 2014.

In order to use this series for comparing imputation algorithm results, there are two time series provided. One series without missing values, which can be used as ground truth. Another series with NAs, on which the imputation algorithms can be applied. The NAs thereby were inserted according to patterns found in similar time series.

There are the two time series:

- tsNH4 - The time series with NAs.
- tsNH4Complete - Time series without NAs.

Source

<http://www.spotseven.de/gecco-challenge/gecco-challenge-2014/>

See Also

[tsAirgap](#), [tsHeating](#)

tsNH4Complete

Time series of NH4 concentration in a wastewater system (complete)

Description

Time series of NH4 concentration in a wastewater system. Measured from 30.11.2010 - 16:10 to 01.01.2011 - 6:40 in 10 minute steps. This time series provides the truth for the missing values of the [tsNH4](#) time series. Thus it is identical to the heating time series except that no value is missing.

Usage

tsNH4Complete

Format

Time Series ([ts](#)) with 4552 rows.

Details

The time series is derived from the dataset of the GECCO Industrial Challenge 2014.

In order to use this series for comparing imputation algorithm results, there are two time series provided. One series without missing values, which can be used as ground truth. Another series with NAs, on which the imputation algorithms can be applied. The NAs thereby were inserted according to patterns found in similar time series.

There are the two time series:

- [tsNH4](#) - The time series with NAs.
- [tsNH4Complete](#) - Time series without NAs.

Source

<http://www.spotseven.de/gecco-challenge/gecco-challenge-2014/>

See Also

[tsAirgap](#), [tsHeating](#)

Index

* datasets

- tsAirgap, [29](#)
- tsAirgapComplete, [30](#)
- tsHeating, [31](#)
- tsHeatingComplete, [32](#)
- tsNH4, [33](#)
- tsNH4Complete, [34](#)

approx, [14](#)

arima, [16](#)

auto.arima, [15](#), [16](#)

Date, [3](#), [9](#)

ggplot2, [6](#)

ggplot_na_distribution, [2](#), [7](#), [10](#), [12](#), [13](#), [29](#)

ggplot_na_gapsize, [4](#), [5](#), [10](#), [13](#), [29](#)

ggplot_na_imputations, [4](#), [7](#), [8](#), [13](#)

ggplot_na_intervals, [4](#), [7](#), [10](#), [11](#), [29](#)

KalmanLike, [16](#)

KalmanRun, [16](#)

KalmanSmooth, [16](#)

list, [29](#)

na_interpolation, [14](#), [17](#), [18](#), [20–24](#), [26](#), [27](#)

na_kalman, [15](#), [15](#), [18](#), [20–24](#), [26](#), [27](#)

na_locf, [15](#), [17](#), [17](#), [20–24](#), [26](#), [27](#)

na_ma, [15](#), [17](#), [18](#), [19](#), [21–24](#), [26](#), [27](#)

na_mean, [15](#), [17](#), [18](#), [20](#), [20](#), [22–24](#), [26](#), [27](#)

na_random, [15](#), [17](#), [18](#), [20](#), [21](#), [22](#), [23](#), [24](#), [26](#),
[27](#)

na_remove, [23](#)

na_replace, [15](#), [17](#), [18](#), [20–23](#), [24](#), [26](#), [27](#)

na_seadec, [15](#), [17](#), [18](#), [20–24](#), [25](#), [27](#)

na_seasplit, [15](#), [17](#), [18](#), [20–24](#), [26](#), [26](#)

nclass.Sturges, [12](#)

POSIXct, [3](#), [9](#)

runif, [22](#)

spline, [14](#)

statsNA, [28](#)

stinterp, [14](#)

StructTS, [16](#)

theme_linedraw, [3](#), [6](#), [9](#), [12](#)

ts, [3](#), [5](#), [8](#), [9](#), [12](#), [14–34](#)

tsAirgap, [29](#), [30–34](#)

tsAirgapComplete, [29](#), [30](#)

tsHeating, [30](#), [31](#), [31](#), [32–34](#)

tsHeatingComplete, [31](#), [32](#)

tsNH4, [30–32](#), [33](#), [34](#)

tsNH4Complete, [33](#), [34](#)

vector, [3](#), [5](#), [12](#), [14–28](#)