

# Package ‘imputeTestbench’

October 13, 2022

**Type** Package

**Title** Test Bench for the Comparison of Imputation Methods

**Date** 2019-07-05

**Maintainer** Marcus W. Beck <mbafs2012@gmail.com>

**Version** 3.0.3

**Description** Provides a test bench for the comparison of missing data imputation methods in uni-variate time series. Imputation methods are compared using different error metrics. Proposed imputation methods and alternative error metrics can be used.

**Imports** dplyr, forecast, ggplot2, imputeTS, reshape2, stats, tidyr, zoo

**BugReports** <https://github.com/neerajdhanraj/imputeTestbench/issues>

**License** CC0

**LazyData** TRUE

**RoxygenNote** 6.1.1

**Suggests** knitr, rmarkdown, magrittr

**NeedsCompilation** no

**Author** Neeraj Bokde [aut],  
Marcus W. Beck [cre, aut]

**Repository** CRAN

**Date/Publication** 2019-07-05 18:10:14 UTC

## R topics documented:

impute_errors . . . . .	2
mae . . . . .	4
mape . . . . .	5
plot_errors . . . . .	5
plot_impute . . . . .	6
print.errprof . . . . .	8
rmse . . . . .	8
sample_dat . . . . .	9

---

impute_errors	<i>Function working as testbench for comparison of imputing models</i>
---------------	--

---

## Description

Function working as testbench for comparison of imputing models

## Usage

```
impute_errors(dataIn, smps = "mcar", methods = c("na.approx",
  "na.interp", "na_interpolation", "na.locf", "na_mean"),
  methodPath = NULL, errorParameter = "rmse", errorPath = NULL,
  blk = 50, blkper = TRUE, missPercentFrom = 10,
  missPercentTo = 90, interval = 10, repetition = 10,
  addl_arg = NULL)
```

## Arguments

dataIn	input <b>ts</b> for testing
smps	chr string indicating sampling type for generating missing data, see details
methods	chr string of imputation methods to use, one to many. A user-supplied function can be included if MethodPath is used, see details.
methodPath	chr string of location of script containing one or more functions for the proposed imputation method(s)
errorParameter	chr string indicating which error type to use, acceptable values are "rmse" (default), "mae", or "mape". Alternatively, a user-supplied function can be passed if errorPath is used, see details.
errorPath	chr string of location of script containing one or more error functions for evaluating imputations
blk	numeric indicating block sizes as a percentage of the sample size for the missing data, applies only if smps = 'mar'
blkper	logical indicating if the value passed to blk is a percentage of the sample size for missing data, otherwise blk indicates number of observations
missPercentFrom	numeric from which percent of missing values to be considered
missPercentTo	numeric for up to what percent missing values are to be considered
interval	numeric for interval between consecutive missPercent values
repetition	numeric for repetitions to be done for each missPercent value
addl_arg	arguments passed to other imputation methods as a list of lists, see details.

## Details

The default methods for `impute_errors` are [na.approx](#), [na.interp](#), [na.interpolation](#), [na.locf](#), and [na.mean](#). See the help file for each for additional documentation. Additional arguments for the imputation functions are passed as a list of lists to the `addl_arg` argument, where the list contains one to many elements that are named by the methods. The elements of the master list are lists with arguments for the relevant methods. See the examples.

A user-supplied function can also be passed to methods as an additional imputation method. A character string indicating the path of the function must also be supplied to `methodPath`. The path must point to a function where the first argument is the time series to impute.

An alternative error function can also be passed to `errorParameter` if `errorPath` is not NULL. The function specified in `errorPath` must have two arguments where the first is a vector for the observed time series and the second is a vector for the predicted time series.

The `smpls` argument indicates the type of sampling for generating missing data. Options are `smpls = 'mcar'` for missing completely at random and `smpls = 'mar'` for missing at random. Additional information about the sampling method is described in [sample\\_dat](#). The relevant arguments for `smpls = 'mar'` are `blk` and `blkper` which greatly affect the sampling method.

Infinite comparisons are removed with a warning if `errorParameter = 'mape'`. This occurs if any of the observed values in the original time series are zero. Error estimates for such datasets are evaluated only for non-zero observations.

## Value

Returns an error comparison for imputation methods as an `errprof` object. This object is structured as a list where the first two elements are named `Parameter` and `MissingPercent` that describe the error metric used to assess the imputation methods and the intervals of missing observations as percentages, respectively. The remaining elements are named as the chr strings in methods of the original function call. Each remaining element contains a numeric vector of the average error at each missing percent of observations. The `errprof` object also includes an attribute named `errall` as an additional list that contains all of the error estimates for every imputation method and repetition.

## See Also

[sample\\_dat](#)

## Examples

```
## Not run:
# default options
aa <- impute_errors(dataIn = nottem)
aa
plot_errors(aa)

# change the simulation for missing obs
aa <- impute_errors(dataIn = nottem, smpls = 'mar')
aa
plot_errors(aa)

# use one interpolation method, increase repetitions
```

```
aa <- impute_errors(dataIn = nottem, methods = 'na.interp', repetition = 100)
aa
plot_errors(aa)

# change the error metric
aa <- impute_errors(dataIn = nottem, errorParameter = 'mae')
aa
plot_errors(aa)

# passing additional arguments to imputation methods
impute_errors(dataIn = nottem, addl_arg = list(na_mean = list(option = 'mode')))

## End(Not run)
```

---

mae

*Mean Absolute Error Calculation*

---

### Description

takes difference between Original data and Predicted data as input

### Usage

```
mae(obs, pred)
```

### Arguments

obs	numeric vector of original data
pred	numeric vector of predicted data

### Value

maeVal as Mean Absolute Error

### Examples

```
## Generate 100 random numbers within some limits
x <- sample(1:7, 100, replace = TRUE)
y <- sample(1:4, 100, replace = TRUE)
z <- mae(x, y)
z
```

---

mape	<i>Mean Absolute Percent Error Calculation</i>
------	--

---

**Description**

takes difference between Original data and Predicted data as input

**Usage**

```
mape(obs, pred)
```

**Arguments**

obs	numeric vector of original data
pred	numeric vector of predicted data

**Value**

mapeVal as Mean Absolute Error

**Examples**

```
## Generate 100 random numbers within some limits
x <- sample(1:7, 100, replace = TRUE)
y <- sample(1:4, 100, replace = TRUE)
z <- mape(x, y)
z
```

---

plot_errors	<i>Function to plot the Error Comparison</i>
-------------	--

---

**Description**

Function to plot the Error Comparison

**Usage**

```
plot_errors(dataIn, plotType = c("boxplot"))

## S3 method for class 'errprof'
plot_errors(dataIn, plotType = c("boxplot"))
```

**Arguments**

dataIn	an errprof object returned from <a href="#">impute_errors</a>
plotType	chr string indicating plot type, accepted values are "boxplot", "bar", or "line"

**Value**

A ggplot object that can be further modified. The entire range of errors are shown if plotType = "boxplot", otherwise the averages are shown if plotType = "bar" or "line".

**Examples**

```
aa <- impute_errors(dataIn = nottem)

# default plot
plot_errors(aa)
## Not run:
# bar plot of averages at each repetition
plot_errors(aa, plotType = 'bar')

# line plot of averages at each repetition
plot_errors(aa, plotType = 'line')

# change the plot aesthetics

library(ggplot2)
p <- plot_errors(aa)
p + scale_fill_brewer(palette = 'Paired', guide_legend(title = 'Default'))
p + theme(legend.position = 'top')
p + theme_minimal()
p + ggtitle('Distribution of error for imputed values')
p + scale_y_continuous('RMSE')

## End(Not run)
```

---

plot\_impute

*Plot imputations*


---

**Description**

Plot imputations for data from multiple methods

**Usage**

```
plot_impute(dataIn, smps = "mcar", methods = c("na.approx",
  "na.interp", "na_interpolation", "na.locf", "na_mean"),
  methodPath = NULL, blkck = 50, blkckper = TRUE, missPercent = 50,
  showmiss = FALSE, addl_arg = NULL)
```

**Arguments**

dataIn           input [ts](#) for testing

smps             chr string indicating sampling type for generating missing data, see details

methods	chr string of imputation methods to use, one to many. A user-supplied function can be included if MethodPath is used.
methodPath	chr string of location of script containing one or more functions for the proposed imputation method(s)
blk	numeric indicating block sizes as a percentage of the sample size for the missing data, applies only if smps = 'mar'
blkper	logical indicating if the value passed to blk is a percentage of the sample size for missing data, otherwise blk indicates number of observations
missPercent	numeric for percent of missing values to be considered
showmiss	logical if removed values missing from the complete dataset are plotted
addl_arg	arguments passed to other imputation methods as a list of lists, see details.

### Details

See the documentation for [impute\\_errors](#) for an explanation of the arguments.

### Value

A [ggplot](#) object showing the imputed data for each method. Red points are labelled as 'imputed' and blue points are labelled as 'retained' from the original data set. Missing data that were removed can be added to the plot as open circles if showmiss = TRUE. See the examples for modifying the plot.

### Examples

```
# default
plot_impute(dataIn = nottem)

# change missing percent total
plot_impute(dataIn = nottem, missPercent = 10)

# show missing values
plot_impute(dataIn = nottem, showmiss = TRUE)

# use mar sampling
plot_impute(dataIn = nottem, smps = 'mar')

# change the plot aesthetics
## Not run:
library(ggplot2)
p <- plot_impute(dataIn = nottem, smps = 'mar')
p + scale_colour_manual(values = c('black', 'grey'))
p + theme_minimal()
p + ggtitle('Imputation examples with different methods')
p + scale_y_continuous('Temp at Nottingham Castle (F)')

## End(Not run)
```

---

print.errprof	<i>Print method for errprof</i>
---------------	---------------------------------

---

**Description**

Print method for errprof class

**Usage**

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

**Arguments**

x	input errprof object
...	arguments passed to or from other methods

**Value**

list output for the errprof object

---

rmse	<i>Root Mean Square Error Calculation</i>
------	---

---

**Description**

takes difference between Original data and Predicted data as input

**Usage**

```
rmse(obs, pred)
```

**Arguments**

obs	numeric vector of original data
pred	numeric vector of predicted data

**Value**

rmseVal as Root Mean Square Error

**Examples**

```
## Generate 100 random numbers within some limits  
x <- sample(1:7, 100, replace = TRUE)  
y <- sample(1:4, 100, replace = TRUE)  
z <- rmse(x, y)  
z
```



---

sample_dat	<i>Sample time series data</i>
------------	--------------------------------

---

### Description

Sample time series using completely at random (MCAR) or at random (MAR)

### Usage

```
sample_dat(datin, smps = "mcar", repetition = 10, b = 10,  
           blk = 50, blkper = TRUE, plot = FALSE)
```

### Arguments

datin	input numeric vector
smps	chr string of sampling type to use, options are "mcar" or "mar"
repetition	numeric for repetitions to be done for each missPercent value
b	numeric indicating the total amount of missing data as a percentage to remove from the complete time series
blk	numeric indicating block sizes as a proportion of the sample size for the missing data
blkper	logical indicating if the value passed to blk is a proportion of missper, i.e., blocks are to be sized as a percentage of the total size of the missing data
plot	logical indicating if a plot is returned showing the sampled data, plots only the first repetition

### Value

Input data with NA values for the sampled observations if plot = FALSE, otherwise a plot showing the missing observations over the complete dataset.

The missing data if smps = 'mar' are based on random sampling by blocks. The start location of each block is random and overlapping blocks are not counted uniquely for the required sample size given by b. Final blocks are truncated to ensure the correct value of b is returned. Blocks are fixed at 1 if the proportion is too small, in which case "mcar" should be used. Block sizes are also truncated to the required sample size if the input value is too large if blkper = FALSE. For the latter case, this is the same as setting blk = 1 and blkper = TRUE.

For all cases, the first and last observation will never be removed to allow comparability of interpolation schemes. This is especially relevant for cases when b is large and smps = 'mar' is used. For example, method = na.approx will have rmse = 0 for a dataset where the removed block includes the last n observations. This result could provide misleading information in comparing methods.

**Examples**

```
a <- rnorm(1000)

# default sampling
sample_dat(a)

# use mar sampling
sample_dat(a, smps = 'mar')

# show a plot of one repetition
sample_dat(a, plot = TRUE)

# show a plot of one repetition, mar sampling
sample_dat(a, smps = 'mar', plot = TRUE)

# change plot aesthetics
library(ggplot2)
p <- sample_dat(a, plot = TRUE)
p + scale_colour_manual(values = c('black', 'grey'))
p + theme_minimal()
p + ggtitle('Example of simulating missing data')
```

# Index

ggplot, 7

impute\_errors, 2, 5, 7

mae, 4

mape, 5

na.approx, 3

na.interp, 3

na.locf, 3

na\_interpolation, 3

na\_mean, 3

plot\_errors, 5

plot\_impute, 6

print.errprof, 8

rmse, 8

sample\_dat, 3, 9

ts, 2, 6