

# Package ‘testarguments’

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**Title** Test (Multiple) Arguments of a User-Defined Prediction Algorithm

**Version** 0.0.1

## Description

Finding the best values for user-specified arguments of a prediction algorithm can be difficult, particularly if there is an interaction between argument levels. This package automates the testing of any user-defined prediction algorithm over an arbitrary number of arguments. It includes functions for testing the algorithm over the given arguments with respect to an arbitrary number of user-defined diagnostics, visualising the results of these tests, and finding the optimal argument combinations with respect to each diagnostic.

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`c, testargs-method`      *Combine objects of class 'testargs'*

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### Description

Combines an arbitrary number of 'testargs' objects

### Usage

```
## S4 method for signature 'testargs'
c(x, ...)
```

### Arguments

`x`                      object of class 'testargs'  
`...`                    objects of class 'testargs' to be combined with `x`

### Details

If the argument and diagnostic names are inconsistent across objects, the combined 'testargs' object is constructed by simply taking the union of all argument and diagnostic names. Then, `rbind.fill()` is used to combine the diagnostic data, producing intentional NA values where appropriate.

### Value

An object of class 'testargs', the result of combining `x` and `...`

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`optimal_arguments`      *Find the optimal combinations of arguments for each diagnostic*

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### Description

The measure of optimality is typically diagnostic dependent; for example, we wish to minimise the RMSE and run time, but we want coverage to be as close to the purported value as possible. Hence, `optimal_arguments()` allows one to set the optimality criteria individually for each diagnostic.

### Usage

```
optimal_arguments(object, optimality_criterion = which.min)
```

**Arguments**

object            an object of class 'testargs'  
 optimality\_criterion    a function (or list of functions) that defines the optimality criterion for each diagnostic. Each function should return a single positive integer indicating the index of the optimal argument combination. If a named list is provided with less elements than the number of diagnostic scores, unspecified diagnostics are assumed to be negatively oriented (i.e., assigned optimality criterion which.min)

**Value**

A data.frame; each row corresponds to one of the diagnostics (specified by the row names), and the columns contain the argument values that optimise the corresponding diagnostic. The diagnostics at each of these optimal argument combinations are also included

**Examples**

```
## See ?test_arguments
```

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plot_diagnostics	<i>Visualise diagnostics across the tested arguments</i>
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**Description**

Using various aesthetics, plot\_diagnostics() can visualise the performance of all combinations of up to 4 different arguments simultaneously.

**Usage**

```
plot_diagnostics(  
  object,  
  focused_args = NULL,  
  average_out_non_focused_args = TRUE,  
  plot_order = NULL  
)
```

**Arguments**

object            an object of class 'testargs'  
 focused\_args    the arguments we wish to plot. If NULL, all arguments are plotted (i.e., focused\_args = object@arg\_names)  
 average\_out\_non\_focused\_args    logical indicating whether we should average over the non-focused arguments  
 plot\_order    specifies the order in which we are to assign arguments to the various aesthetics. If NULL, the arguments are assigned based on their type, in the order 'numeric', 'integer', 'factor', 'character', and 'logical'. Otherwise, plot\_order should be an integer vector with the same length as focused\_args

**Value**

a faceted 'ggplot' object, where:

- the columns of the facet are split by the diagnostics
- the y-axis corresponds to the values of the diagnostics
- the x-axis corresponds to the first argument
- the colour scale and grouping correspond to the second argument (if present)
- if a third argument is present, `facet_grid()` is used, whereby columns correspond to levels of the third argument, and rows correspond to diagnostics. Note that `facet_grid()` forces a given row to share a common y-scale, so the plot would be misleading if diagnostics were kept as columns
- the shape of the points corresponds to the fourth argument (if present)

**Examples**

```
## See ?test_arguments
```

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testargs-class	'testargs' class
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**Description**

This is the central class definition of the testarguments package, containing all information from a call to [test\\_arguments](#)

**Slots**

diagnostics\_df a data.frame containing the diagnostics for each combination of the supplied arguments

arg\_names the argument names

diagnostic\_names the diagnostic names

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test_arguments	<i>Test (multiple) arguments of a prediction algorithm</i>
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**Description**

Test the performance of a prediction algorithm over a range of argument values. Multiple arguments can be tested simultaneously.

**Usage**

```
test_arguments(pred_fun, df_train, df_test, diagnostic_fun, arguments)
```

**Arguments**

pred_fun	The prediction algorithm to be tested. It should be a function with formal arguments df_train and df_test, which are data used to train the model and test out-of-sample predictive performance, respectively, as well as any arguments which are to be tested. The value of pred_fun should be a matrix-like object with named columns and the same number of rows as df_test
df_train	training data
df_test	testing data
diagnostic_fun	the criteria with which the predictive performance will be assessed
arguments	named list of arguments and their values to check

**Details**

For each combination of the supplied argument levels, the value of pred\_fun() is combined with df\_test using cbind(), which is then passed into diagnostic\_fun() to compute the diagnostics. Since the number of columns in the returned value of pred\_fun() is arbitrary, one can test both predictions and uncertainty quantification of the predictions (e.g., by including prediction standard errors or predictive interval bounds)

**Value**

an object of class 'testargs' containing all information from the testing procedure

**See Also**

[plot\\_diagnostics](#), [optimal\\_arguments](#)

**Examples**

```
library("testarguments")

## Simulate training and testing data
RNGversion("3.6.0"); set.seed(1)
n <- 1000 # sample size
x <- seq(-1, 1, length.out = n) # covariates
mu <- exp(3 + 2 * x * (x - 1) * (x + 1) * (x - 2)) # polynomial function in x
Z <- rpois(n, mu) # simulate data
df <- data.frame(x = x, Z = Z, mu = mu)
train_id <- sample(1:n, n/2, replace = FALSE)
df_train <- df[train_id, ]
df_test <- df[-train_id, ]

## Algorithm that uses df_train to predict over df_test. We use glm(), and
## test the degree of the regression polynomial and the link function.
pred_fun <- function(df_train, df_test, degree, link) {

  M <- glm(Z ~ poly(x, degree), data = df_train,
           family = poisson(link = as.character(link)))
```

```
## Predict over df_test
pred <- as.data.frame(predict(M, df_test, type = "link", se.fit = TRUE))

## Compute response level predictions and 90% prediction interval
inv_link <- family(M)$linkinv
fit_Y <- pred$fit
se_Y <- pred$se.fit
pred <- data.frame(fit_Z = inv_link(fit_Y),
                  upr_Z = inv_link(fit_Y + 1.645 * se_Y),
                  lwr_Z = inv_link(fit_Y - 1.645 * se_Y))

return(pred)
}

## Define diagnostic function. Should return a named vector
diagnostic_fun <- function(df) {
  with(df, c(
    RMSE = sqrt(mean((Z - fit_Z)^2)),
    MAE = mean(abs(Z - fit_Z)),
    coverage = mean(lwr_Z < mu & mu < upr_Z)
  ))
}

## Compute the user-defined diagnostics over a range of argument levels
testargs_object <- test_arguments(
  pred_fun, df_train, df_test, diagnostic_fun,
  arguments = list(degree = 1:6, link = c("log", "sqrt"))
)

## Visualise the performance across all combinations of the supplied arguments
plot_diagnostics(testargs_object)

## Focus on a subset of the tested arguments
plot_diagnostics(testargs_object, focused_args = "degree")

## Compute the optimal arguments for each diagnostic
optimal_arguments(
  testargs_object,
  optimality_criterion = list(coverage = function(x) which.min(abs(x - 0.90)))
)
```

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