

# Package ‘proxy’

December 11, 2025

**Type** Package

**Title** Distance and Similarity Measures

**Version** 0.4-28

**Description** Provides an extensible framework for the efficient calculation of auto- and cross-proximities, along with implementations of the most popular ones.

**Depends** R (>= 3.4.0)

**Imports** stats, utils

**Suggests** cba

**Collate** registry.R database.R dist.R similarities.R dissimilarities.R  
util.R seal.R

**License** GPL-2 | GPL-3

**NeedsCompilation** yes

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**Repository** CRAN

**Date/Publication** 2025-12-11 15:24:53 UTC

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dist

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Matrix Distance/Similarity Computation

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## Description

These functions compute and return the auto-distance/similarity matrix between either rows or columns of a matrix/data frame, or a list, as well as the cross-distance matrix between two matrices/data frames/lists.

## Usage

```
dist(x, y = NULL, method = NULL, ..., diag = FALSE, upper = FALSE,
     pairwise = FALSE, by_rows = TRUE, convert_similarities = TRUE,
     auto_convert_data_frames = TRUE)
simil(x, y = NULL, method = NULL, ..., diag = FALSE, upper = FALSE,
     pairwise = FALSE, by_rows = TRUE, convert_distances = TRUE,
     auto_convert_data_frames = TRUE)

pr_dist2simil(x)
pr_simil2dist(x)

as.dist(x, FUN = NULL)
as.simil(x, FUN = NULL)

## S3 method for class 'dist'
as.matrix(x, diag = 0, ...)
## S3 method for class 'simil'
as.matrix(x, diag = NA, ...)
```

## Arguments

x	For <code>dist</code> and <code>simil</code> , a numeric matrix object, a data frame, or a list. A vector will be converted into a column matrix. For <code>as.simil</code> and <code>as.dist</code> , an object of class <code>dist</code> and <code>simil</code> , respectively, or a numeric matrix. For <code>pr_dist2simil</code> and <code>pr_simil2dist</code> , any numeric vector.
y	<code>NULL</code> , or a similar object than x
method	a function, a registry entry, or a mnemonic string referencing the proximity measure. A list of all available measures can be obtained using <code>pr_DB</code> (see examples). The default for <code>dist</code> is "Euclidean", and for <code>simil</code> "correlation".
diag	logical value indicating whether the diagonal of the distance/similarity matrix should be printed by <code>print.dist/print.simil</code> . Note that the diagonal values are never stored in <code>dist</code> objects.  In the context of <code>as.matrix</code> the value to use on the diagonal representing self-proximities. In case of similarities, this defaults to <code>NA</code> since a priori there are no upper bounds, so the maximum similarity needs to be specified by the user.

upper	logical value indicating whether the upper triangle of the distance/similarity matrix should be printed by <code>print.dist/print.simil</code>
pairwise	logical value indicating whether distances should be computed for the pairs of x and y only.
by_rows	logical indicating whether proximities between rows, or columns should be computed.
convert_similarities, convert_distances	logical indicating whether distances should be automatically converted into similarities (and the other way round) if needed.
auto_convert_data_frames	logical indicating whether data frames should be converted to matrices if all variables are numeric, or all are logical, or all are complex.
FUN	optional function to be used by <code>as.dist</code> and <code>as.simil</code> . If NULL, it is looked up in the method registry. If there is none specified there, FUN defaults to <code>pr_simil2dist</code> and <code>pr_dist2simil</code> , respectively.
...	further arguments passed to the proximity function.

## Details

The interface is fashioned after `dist`, but can also compute cross-distances, and allows user extensions by means of registry of all proximity measures (see `pr_DB`).

Missing values are allowed but are excluded from all computations involving the rows within which they occur. If some columns are excluded in calculating a Euclidean, Manhattan, Canberra or Minkowski distance, the sum is scaled up proportionally to the number of columns used (compare `dist` in package `stats`).

Data frames are silently coerced to matrix if all columns are of (same) mode numeric or logical.

Distance measures can be used with `simil`, and similarity measures with `dist`. In these cases, the result is transformed accordingly using the specified coercion functions (default:  $\text{pr\_simil2dist}(x) = 1 - \text{abs}(x)$  and  $\text{pr\_dist2simil}(x) = 1/(1 + x)$ ). Objects of class `simil` and `dist` can be converted one in another using `as.dist` and `as.simil`, respectively.

Distance and similarity objects can conveniently be subset (see examples). Note that duplicate indexes are silently ignored.

## Value

Auto distances/similarities are returned as an object of class `dist/simil` and cross-distances/similarities as an object of class `crossdist/crosssimil`.

## Author(s)

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## References

Anderberg, M.R. (1973), *Cluster analysis for applications*, 359 pp., Academic Press, New York, NY, USA.

Cox, M.F. and Cox, M.A.A. (2001), *Multidimensional Scaling*, Chapman and Hall.

Sokol, R.S. and Sneath P.H.A (1963), *Principles of Numerical Taxonomy*, W. H. Freeman and Co., San Francisco.

### See Also

[dist](#) for compatibility information, and [pr\\_DB](#) for the proximity data base.

### Examples

```
### show available proximities
summary(pr_DB)

### get more information about a particular one
pr_DB$get_entry("Jaccard")

### binary data
x <- matrix(sample(c(FALSE, TRUE), 8, replace = TRUE), ncol = 2)
dist(x, method = "Jaccard")

### for real-valued data
dist(x, method = "eJaccard")

### for positive real-valued data
dist(x, method = "fJaccard")

### cross distances
dist(x, x, method = "Jaccard")

### pairwise (diagonal)
dist(x, x, method = "Jaccard",
    pairwise = TRUE)

### this is the same but less efficient
as.matrix(stats::dist(x, method = "binary"))

### numeric data
x <- matrix(rnorm(16), ncol = 4)

## test inheritance of names
rownames(x) <- LETTERS[1:4]
colnames(x) <- letters[1:4]
dist(x)
dist(x, x)

## custom distance function
f <- function(x, y) sum(x * y)
dist(x, f)

## working with lists
z <- unlist(apply(x, 1, list), recursive = FALSE)
(d <- dist(z))
```

```

dist(z, z)

## subsetting
d[[1:2]]
subset(d, c(1,3,4))
d[[c(1,2,2)]] # duplicate index gets ignored

## transformations and self-proximities
as.matrix(as.simil(d, function(x) exp(-x)), diag = 1)

## row and column indexes
row.dist(d)
col.dist(d)

```

pr\_DB

*Registry of proximities***Description**

Registry containing similarities and distances.

**Usage**

```

pr_DB
pr_DB$get_field(name)
pr_DB$get_fields()
pr_DB$get_field_names()
pr_DB$set_field(name, default = NA, type = NA, is_mandatory = FALSE,
               is_modifiable = TRUE, validity_FUN = NULL)

pr_DB$entry_exists(name)
pr_DB$get_entry(name)
pr_DB$get_entries(name = NULL, pattern = NULL)
pr_DB$get_entry_names(name)
pr_DB$set_entry(...)
pr_DB$modify_entry(...)
pr_DB$delete_entry(name)

## S3 method for class 'pr_DB'
summary(object, verbosity = c("short", "long"), ...)

```

**Arguments**

name	character string representing the name of an entry (case-insensitive).
pattern	regular expression to be matched to all fields of class "character" in all entries.
default	optional default value for the field.

type	optional character string specifying the class to be required for this field. If type is a character vector with more than two elements, the entries will be used as fixed set of alternatives. If type is not a character string or vector, the class will be inferred from the argument given.
is_mandatory	logical specifying whether new entries are required to have a value for this field.
is_modifiable	logical specifying whether entries can be changed with respect to that field.
validity_FUN	optional function or character string with the name of a function that checks the validity of a field entry. Such a function gets the value to be investigated as argument, and should stop with an error message if the value is not correct.
object	a registry object.
verbosity	controlling the verbosity of the output of the summary method for the registry. "short" gives just a list, "long" also gives the formulas.
...	for pr_DB\$set_entry and pr_DB\$modify_entry: named list of fields to be modified in or added to the registry (see details). This must include the index field ("names").

## Details

pr\_DB represents the registry of all proximity measures available. For each measure, it comprises meta-information that can be queried and extended. Also, new measures can be added. This is done using the following accessor functions of the pr\_DB object:

get\_field\_names() returns a character vector with all field names. get\_field() returns the information for a specific field as a list with components named as described above. get\_fields() returns a list with all field entries. set\_field() is used to create new fields in the repository (the default value will be set in all entries).

get\_entry\_names() returns a character vector with (the first alias of) all entries. entry\_exists() is a predicate checking if an entry with the specified alias exists in the registry. get\_entry() returns the specified entry if it exists (and, by default, gives an error if it does not). get\_entries() is used to query more than one entry: either those matching name exactly, or those where the regular expression in pattern matches *any* character field in an entry. By default, all values are returned. delete\_entry removes an existing entry from the registry (note that only user-provided entries can be deleted). set\_entry and modify\_entry require a named list of arguments used as field entries. At least the names index field is required. set\_entry will check for all other mandatory fields. If specified in the field meta data, each field entry and the entry as a whole is checked for validity. Note that only user-specified fields and/or entries can be modified, the data shipped with the package are read-only.

The registry fields currently available are as follows:

**FUN** Function to register (see below).

**names** Character vector with an alias(es) for the measure.

**PREFUN** Optional function (or function name) for preprocessing code (see below).

**POSTFUN** Optional function (or function name) for postprocessing code (see below).

**distance** logical indicating whether this measure is a distance (TRUE) or similarity (FALSE).

**convert** Optional Function or function name for converting between similarities and distances when needed.

**type** Optional, the scale the measure applies to ("metric", "ordinal", "nominal", "binary", or "other"). If NULL, it is assumed to apply to some other unknown scale.

**loop** logical indicating whether FUN is just a measure, and therefore, if [dist](#) shall do the loop over all pairs of observations/variables, or if FUN does the loop on its own.

**C\_FUN** logical indicating whether FUN is a C function.

**abcd** logical; if TRUE and binary data (or data to be interpreted as such) are supplied, the number of concordant and discordant pairs is precomputed for every two binary data vectors and supplied to the measure function.

**formula** Optional character string with the symbolic representation of the formula.

**reference** Optional reference (character).

**description** Optional description (character). Ideally, describes the context in which the measure can be applied.

A function specified as FUN parameter has mandatory arguments *x* and *y* (if *abcd* is FALSE), and *a*, *b*, *c*, *d*, *n* otherwise. Additionally, it gets all optional parameters specified by the user in the ... argument of the [dist](#) and [simil](#) functions, possibly changed and/or complemented by the corresponding (optional) PREFUN function. It must return the (diss-)similarity value computed from the arguments. *x* and *y* are two vectors from the data matrix (matrices) supplied. If *abcd* is FALSE, it is assumed that binary measures will be used, and the number of all *n* concordant and discordant pairs (*x\_k*, *y\_k*) precomputed and supplied instead of *x* and *y*. *a*, *b*, *c*, and *d* are the counts of all (TRUE, TRUE), (TRUE, FALSE), (FALSE, TRUE), and (FALSE, FALSE) pairs, respectively.

A function specified as PREFUN parameter has mandatory arguments *x*, *y*, *p*, and *reg\_entry*, with *y* and *p* possibly being NULL depending on the task at hand. *x* and *y* are the data objects, *p* is a (possibly empty) list with all specified proximity parameters, and *reg\_entry* is the registry entry (a named list containing all information specified in *reg\_add*). The preprocessing function is allowed to change all these information, and if so, is required to return *\*all\** arguments as a named list in the same order.

A function specified as POSTFUN parameter has two mandatory arguments: *result* and *p*. *result* will contain the computed raw data, i.e. a vector of length  $n * (n - 1) / 2$  for auto-distances (see [dist](#) for details on *dist* objects), or a matrix for cross-distances. *p* contains the specified proximity parameters. Post-processing functions need to return the *result* object (even if unmodified).

A function specified as *convert* parameter should preserve the type of its argument.

## Author(s)

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## See Also

[dist](#)

## Examples

```
## create a new distance measure
mydist <- function(x,y) x * y

## create a new entry in the registry with two aliases
```

```

pr_DB$set_entry(FUN = mydist, names = c("test", "mydist"))

## look it up (index is case insensitive):
pr_DB$get_entry("TEST")

## modify the content of the description field in the new entry
pr_DB$modify_entry(names = "test", description = "foo function")

## create a new field
pr_DB$set_field("New")

## look up the test entry again (two ways)
pr_DB$get_entry("test")
pr_DB[["test"]]

## show total number of entries
length(pr_DB)

## show all entries (short list)
pr_DB$get_entries(pattern = "foo")

## show more details
summary(pr_DB, "long")

## get all entries in a list (and extract first two ones)
pr_DB$get_entries()[1:2]

## get all entries as a data frame (select first 3 fields)
as.data.frame(pr_DB)[,1:3]

## delete test entry
pr_DB$delete_entry("test")

## check if it is really gone
pr_DB$entry_exists("test")

```

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rowSums.dist

*Row Sums/Mean of Sparse Symmetric Matrices*


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## Description

Compute the row (column) sums or means for a sparse symmetric (distance) matrix.

## Usage

```

rowSums.dist(x, na.rm = FALSE)
rowMeans.dist(x, na.rm = FALSE, diag = TRUE)

colSums.dist(x, na.rm = FALSE)
colMeans.dist(x, na.rm = FALSE, diag = TRUE)

```



**Arguments**

<code>x</code>	an object of class <code>dist</code> .
<code>na.rm</code>	logical, should missing values (including <code>NaN</code> ) be omitted from the summation?
<code>diag</code>	logical, should the diagonal elements be included in the computation?

**Details**

These functions are more efficient than expanding an object of class `dist` to matrix and using `rowSums` or `rowMeans`.

`colSums` and `colMeans` are provided for convenience. However, note that due to symmetry the result is always the same as for `rowSums` or `rowMeans`.

**Value**

A numeric vector of row sums.

**Author(s)**

Christian Buchta

**See Also**

`as.matrix`, `as.dist`, and `rowSums`.

**Examples**

```
##
x <- matrix(runif(10*2),ncol=2)
d <- dist(x)
rowSums(as.matrix(d))
rowSums.dist(d) # the same

rowMeans(as.matrix(d))
rowMeans.dist(d) # the same
rowMeans.dist(d, diag = FALSE) # not the same
## NAs
d[3] <- NA
rowSums.dist(d, na.rm = TRUE)
rowMeans.dist(d, na.rm = TRUE)
```

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