

Package ‘ecodist’

April 7, 2020

Version 2.0.5

Date 2020-04-02

Title Dissimilarity-Based Functions for Ecological Analysis

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Depends R (>= 3.0.0)

LazyData true

Imports stats, graphics

Suggests knitr, testthat

VignetteBuilder knitr

Description Dissimilarity-based analysis functions including ordination and Mantel test functions, intended for use with spatial and community data. The original package description is in Goslee and Urban (2007) <doi:10.18637/jss.v022.i07>, with further statistical detail in Goslee (2010) <doi:10.1007/s11258-009-9641-0>.

License GPL (>= 2)

BugReports <https://github.com/phiala/ecodist/issues>

NeedsCompilation yes

Repository CRAN

Date/Publication 2020-04-07 10:00:28 UTC

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ecodist-package

Dissimilarity-Based Functions for Ecological Analysis

Description

Dissimilarity-based analysis functions including ordination and Mantel test functions, intended for use with spatial and community data.

Details

This package contains well-established dissimilarity-based ecological analyses, such as `nmnds` and `mantel`, and experimental/research analyses such as `xmantel`. Helper functions such as `crosstab` and `cor2m` facilitate analysis of community data.

Because many of the analyses are time-consuming, this package includes worked examples that can be loaded using `data()`.

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vf	Vector fitting
xdistance	Cross-distance between two datasets.
xmantel	Cross-Mantel test
xmgram	Cross-Mantel correlogram
z.no	Example for pmgram
z.z1	Example for pmgram

Author(s)

Sarah Goslee and Dean Urban

Maintainer: Sarah Goslee <Sarah.Goslee@ars.usda.gov>

 addord

Fit new points to an existing NMDS configuration.

Description

Uses a brute force algorithm to find the location for each new point that minimizes overall stress.

Usage

```
addord(origconf, fulldat, fulldist, isTrain, bfstep = 10, maxit = 50, epsilon = 1e-12)
```

Arguments

origconf	The original ordination configuration.
fulldat	The dataset containing original and new points.
fulldist	A dissimilarity matrix calculated on fulldat.
isTrain	A boolean vector of length nrow(fulldat) indicating which rows were training data used in determining origconf (TRUE), or are new points (FALSE).
bfstep	A tuning parameter for the brute force algorithm describing the size of grid to use.
maxit	The maximum number of iterations to use.
epsilon	Tolerance value for convergence.

Details

A region comprising the original ordination configuration plus one standard deviation is divided into a grid of bfstep rows and columns. For a new point, the grid cell with the lowest stress is identified. That cell is divided into a finer grid, and the lowest-stress cell identified. This process is repeated up to maxit times, or until stress changes less than epsilon.

Value

fullfitconf	The new ordination configuration containing training and new points.
stress	The stress value for each point.
isTrain	The boolean vector indicating training set membership, for reference.

Author(s)

Sarah Goslee

Examples

```
data(iris)
iris.d <- dist(iris[,1:4])

### nmds() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.nmds <- nmds(iris.d, nits=20, mindim=1, maxdim=4)
### save(iris.nmds, file="ecodist/data/iris.nmds.rda")
data(iris.nmds)
```

```
# examine fit by number of dimensions
plot(iris.nmds)

# choose the best two-dimensional solution to work with
iris.nmin <- min(iris.nmds, dims=2)

# rotate the configuration to maximize variance
iris.rot <- princomp(iris.nmin)$scores

# rotation preserves distance apart in ordination space
cor(dist(iris.nmin), dist(iris.rot))

# fit the data to the ordination as vectors
### vf() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.vf <- vf(iris.nmin, iris[,1:4], nperm=1000)
### save(iris.vf, file="ecodist/data/iris.vf.rda")
data(iris.vf)

# repeat for the rotated ordination
### vf() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.vfrot <- vf(iris.rot, iris[,1:4], nperm=1000)
### save(iris.vfrot, file="ecodist/data/iris.vfrot.rda")
data(iris.vfrot)

par(mfrow=c(1,2))
plot(iris.nmin, col=as.numeric(iris$Species), pch=as.numeric(iris$Species), main="NMDS")
plot(iris.vf)
plot(iris.rot, col=as.numeric(iris$Species), pch=as.numeric(iris$Species), main="Rotated NMDS")
plot(iris.vfrot)

##### addord example

# generate new data points to add to the ordination
# this might be new samples, or a second dataset

iris.new <- structure(list(Sepal.Length = c(4.6, 4.9, 5.4, 5.2, 6, 6.5, 6,
6.8, 7.3), Sepal.Width = c(3.2, 3.5, 3.6, 2.3, 2.8, 3, 2.7, 3.1,
3.2), Petal.Length = c(1.2, 1.5, 1.5, 3.5, 4.1, 4.2, 4.8, 5,
5.7), Petal.Width = c(0.26, 0.26, 0.26, 1.2, 1.3, 1.4, 1.8, 2,
2), Species = structure(c(1L, 1L, 1L, 2L, 2L, 2L, 3L, 3L, 3L), .Label = c("setosa",
"versicolor", "virginica"), class = "factor")), .Names = c("Sepal.Length",
"Sepal.Width", "Petal.Length", "Petal.Width", "Species"), class = "data.frame", row.names = c(NA,
-9L))

# provide a dist object containing original and new data
# provide a logical vector indicating which samples were used to
# construct the original configuration

iris.full <- rbind(iris, iris.new)
```

```

all.d <- dist(iris.full[,1:4])
is.orig <- c(rep(TRUE, nrow(iris)), rep(FALSE, nrow(iris.new)))

### addord() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.fit <- addord(iris.nmin, iris.full[,1:4], all.d, is.orig, maxit=100)
### save(iris.fit, file="ecodist/data/iris.fit.rda")
data(iris.fit)

plot(iris.fit$conf, col=iris.full$Species, pch=c(18, 4)[is.orig + 1], xlab="NMDS 1", ylab="NMDS 2")
title("Demo: adding points to an ordination")
legend("bottomleft", c("Training set", "Added point"), pch=c(4, 18))
legend("topright", levels(iris$Species), fill=1:3)

```

bcdist

Bray-Curtis distance

Description

Returns the Bray-Curtis (also known as Sorenson, 1 - percent similarity) pairwise distances for the objects in the data. It is duplicated by functionality within [distance](#) but remains for backward compatibility and because it is substantially faster.

Usage

```
bcdist(x, rmzero = FALSE)
```

Arguments

x	matrix or data frame with rows as samples and columns as variables (such as species). Distances will be calculated for each pair of rows.
rmzero	If rmzero=TRUE, empty rows will be removed from the data before distances are calculated. Otherwise, the distance between two empty rows is assumed to be 0 (the default).

Value

This function returns a column-order lower-triangular distance matrix. The returned object has an attribute, Size, giving the number of objects, that is, nrow(x). The length of the vector that is returned is $nrow(x) * (nrow(x) - 1) / 2$.

Author(s)

Sarah Goslee

See Also

[dist](#), [distance](#)

Examples

```
data(graze)
system.time(graze.bc <- bcdist(graze[, -c(1:2)]))
# equivalent to but much faster than:
system.time(graze.bc2 <- distance(graze[, -c(1:2)], "bray-curtis"))

all.equal(graze.bc, graze.bc2)
```

bump

Nine-bump spatial pattern

Description

A two-dimensional artificial "landscape" illustrating the kind of spatial pattern that might be seen across mountain peaks.

Usage

```
data(bump)
```

Format

The format is: int [1:25, 1:25] 2 2 2 2 2 2 2 2 2 ... - attr(*, "dimnames")=List of 2 ..\$: chr [1:25] "1" "3" "5" "7"\$: chr [1:25] "V1" "V3" "V5" "V7" ...

Author(s)

Sarah Goslee

See Also

[bump.pmgram](#), [pmgram](#)

Examples

```
data(bump)
image(bump)
```

bump.pmgram

Nine-bump spatial pattern

Description

An object of class `mgram` for use in the example for `pmgram`. Many of the functions in `ecodist` take a long time to run, so prepared examples have been included.

Usage

```
data(bump.pmgram)
```

Format

See `pmgram` for current format specification.

Author(s)

Sarah Goslee

See Also

[bump](#), [pmgram](#)

Examples

```
data(bump)

par(mfrow=c(1, 2))
image(bump, col=gray(seq(0, 1, length=5)))

z <- as.vector(bump)
x <- rep(1:25, times=25)
y <- rep(1:25, each=25)

X <- col(bump)
Y <- row(bump)
# calculate dissimilarities for data and space
geo.dist <- dist(cbind(as.vector(X), as.vector(Y)))
value.dist <- dist(as.vector(bump))

### pgram() is time-consuming, so this was generated
### in advance and saved.
### set.seed(1234)
### bump.pmgram <- pmgram(value.dist, geo.dist, nperm=10000)
### save(bump.pmgram, file="ecodist/data/bump.pmgram.rda")

data(bump.pmgram)
plot(bump.pmgram)
```

cor2m	<i>Two-matrix correlation table</i>
-------	-------------------------------------

Description

Generate a correlation table between the variables of two data sets, originally for comparing species abundances and environmental variables.

Usage

```
cor2m(x, y, trim = TRUE, alpha = 0.05)
```

Arguments

x	A matrix or data frame of environmental (or other) variables matching the sites of x
y	A matrix or data frame of species (or other) variables
trim	If trim is TRUE, set rho<critical value(alpha) to 0
alpha	alpha p-value to use with trim, by default 0.05

Details

cor2m generates a correlation table between the variables of two matrices. The original use case is to compare species abundances and environmental variables. It results in a data frame with species (or the first matrix) as columns and environmental variables (or the second matrix) as rows, so it's easy to scan. Correlations less than a user-specified alpha (0.05 by default) can be set to NA. cor2m generates a correlation table between the variables of two matrices. The original use case is to compare species abundances and environmental variables. The result has species (or the first matrix) as columns and environmental variables (or the second matrix) as rows, so it's easy to scan. Correlations less than a user-specified alpha can be set to NA. If trim, correlations less than the critical value for the provided alpha are set to to NA. The critical value is computed as a t-test with n-2 df. cor2m(x, y, trim=FALSE) is equivalent to cor(x, y)

Value

Returns a data frame of correlations between the variables of 2 data frames.

Author(s)

Dean Urban

Examples

```
data(graze)
speciesdata <- graze[, 3:7]
envdata <- graze[, 1:2]
sppenv.cor <- cor2m(envdata, speciesdata)
print(sppenv.cor, na.print="")
```

 corgen

Generate correlated data

Description

Generate correlated data of a given length.

Usage

```
corgen(len, x, r, population = FALSE, epsilon = 0)
```

Arguments

len	Length of vectors.
x	Independent data. If x is specified, the population parameter is automatically set to TRUE.
r	Desired correlation between data vectors.
population	TRUE for vectors drawn from two populations with correlation r, otherwise r is the sample correlation.
epsilon	Desired tolerance.

Details

Either x or len must be specified. If epsilon = 0, it has no effect, otherwise the sampling process is repeated until the sample correlation is within epsilon of r. This option allows the production of exactly-correlated data, within the limits of epsilon. Setting epsilon > 0 invalidates the population setting; data will be correlated within that range, rather than sampled from that population. If epsilon = 0, it has no effect, otherwise the sampling process is repeated until the sample correlation is within epsilon of r. This option allows the production of exactly-correlated data, within the limits of epsilon. Setting epsilon > 0 invalidates the population setting; data will be correlated within that range, rather than sampled from that population.

Value

x	First data vector, either generated by corgen or given by the user.
y	Second data vector.

Author(s)

Sarah Goslee

Examples

```
# create two random variables of length 100 with correlation
# of 0.10 +/- 0.01
xy <- corgen(len=100, r=.1, epsilon=0.01)
with(xy, cor(x, y))

# create two random variables of length 100 drawn from a population with
# a correlation of -0.82
xy <- corgen(len=100, r=-0.82, population=TRUE)
with(xy, cor(x, y))

# create a variable y within 0.01 of the given correlation to x
x <- 1:100
y <- corgen(x=x, r=.5, epsilon=.01)$y
cor(x, y)
```

crosstab

Data formatting

Description

Converts field data of the form site, species, observation into a site by species data frame.

Usage

```
crosstab(rowlab, collab, values, type = "sum", data, allrows, allcols,
na.as.0 = TRUE, check.names = TRUE, ...)
```

Arguments

rowlab	row labels, e.g. site names.
collab	column labels, e.g. species names.
values	data values.
data	optional data frame from which to take rowlab, collab and/or values.
type	function to use to combine data, one of "sum" (default), "min", "max", "mean", "count".
allrows	optional, list of all desired row names that may not appear in rowlab.
allcols	optional, list of all desired column names that may not appear in collab.
na.as.0	if TRUE, all NA values are replaced with 0.
check.names	if FALSE, data frame names are not checked for syntactic validity, so that they match the input categories. Otherwise make.names() is used to adjust them.
...	optional arguments to the function specified in type, such as na.rm=TRUE

Details

Field data are often recorded as a separate row for each site-species combination. This function reformats such data into a data frame for further analysis based on unique row and column labels. The three vectors should all be the same length (including duplicates). The three vectors may also be provided as names of columns in the data frame specified by the data argument.

If allrows or allcols exists, rows and/or columns of zeros are inserted for any elements of allrows/allcols not present in rowlab/collab.

If values is missing the number of occurrences of combinations of rowlab and collab will be returned. Thus, crosstab(rowlab, collab) is equivalent to table(rowlab, collab).

If type is "count", the unique combinations of rowlab, collab and values will be returned.

Value

data frame with rowlab as row headings, collab as columns, and values as the data.

Author(s)

Sarah Goslee

Examples

```
# Make a random example
plotnames <- rep(1:5, each = 6)
speciesnames <- rep(c("A", "B", "C"), 10)
freqdata <- runif(30)

# number of samples of each species and plot
crosstab(plotnames, speciesnames)

# can use the data argument
speciesdata <- data.frame(plots = plotnames, species = speciesnames,
  freq = freqdata, stringsAsFactors=FALSE)

# mean frequency by species and plot
crosstab(plots, species, freq, data=speciesdata, type="mean")

# can specify additional possible row or column levels
crosstab(plots, species, freq, data=speciesdata, type="mean", allcols=LETTERS[1:5])
```

distance

Calculate dissimilarity/distance metrics

Description

This function calculates a variety of dissimilarity or distance metrics. Although it duplicates the functionality of dist() and bcdist(), it is written in such a way that new metrics can easily be added. distance() was written for extensibility and understandability, and is not necessarily an efficient choice for use with large matrices.

Usage

```
distance(x, method = "euclidean", sprange=NULL, spweight=NULL, icov)
```

Arguments

<code>x</code>	matrix or data frame with rows as samples and columns as variables (such as species). Distances will be calculated for each pair of rows.
<code>method</code>	Currently 7 dissimilarity metrics can be calculated: "euclidean", "bray-curtis", "manhattan", "mahalanobis" (squared Mahalanobis distance), "jaccard", "difference", "sorensen", "gower", "modgower10" (modified Gower, base 10), "modgower2" (modified Gower, base 2). Partial matching will work for selecting a method.
<code>sprange</code>	Gower dissimilarities offer the option of dividing by the species range. If <code>sprange=NULL</code> no range is used. If <code>sprange</code> is a vector of length <code>nrow(x)</code> it is used for standardizing the dissimilarities.
<code>spweight</code>	Euclidean, Manhattan, and Gower dissimilarities allow weighting. If <code>spweight=NULL</code> , no weighting is used. If <code>spweight="absence"</code> , then $W=0$ if both species are absent and 1 otherwise, thus deleting joint absences.
<code>icov</code>	Optional covariance matrix; only used if <code>method="mahalanobis"</code> since Mahalanobis distance requires calculating the variance-covariance matrix for the entire dataset. Providing <code>icov</code> directly makes it possible to calculate distances for a subset of the full dataset.

Value

Returns a lower-triangular distance matrix as an object of class "dist".

Author(s)

Sarah Goslee

See Also

[dist](#), [bcdist](#)

Examples

```
data(iris)
iris.bc <- distance(iris[, 1:4], "bray-curtis")

# The effect of specifying icov:

# calculate Mahalanobis distance for the full iris dataset
iris.md <- full(distance(iris[, 1:4], "mahal"))
iris.md[1, 2] # Mahalanobis distance between samples 1 and 2

# calculate Mahalanobis for just one species
setosa.md <- full(distance(iris[iris$Species == "setosa", 1:4], "mahal"))
setosa.md[1, 2] # Mahalanobis distance between samples 1 and 2
```

```
# use the covariance matrix for the full dataset to scale for one species
setosa.scaled.md <- full(distance(iris[iris$Species == "setosa", 1:4],
  "mahal", icov=var(iris[,1:4])))
setosa.scaled.md[1, 2] # Mahalanobis distance between samples 1 and 2
```

fixdmat

Distance matrix conversion

Description

Convert a row-order lower-triangular distance matrix to a full symmetric matrix.

Usage

```
fixdmat(v)
```

Arguments

v lower-triangular distance matrix in row order.

Details

R distance functions such as `dist` and `bedist` return a lower triangular distance matrix in column order. Some other programs return the lower triangular matrix in row order. To use this matrix in R functions, it must be converted from row order to column order.

Value

full symmetric distance matrix.

Author(s)

Sarah Goslee

See Also

[lower](#), [full](#)

Examples

```
x.vec <- seq_len(6)
x.vec

# Make an R-style column order symmetric matrix
full(x.vec)

# Extract the lower triangle from a symmetric matrix
```

```
# in column order
lower(full(x.vec))

# Convert to or from a row order symmetric matrix
fixdmat(x.vec)
lower(fixdmat(x.vec))

fixdmat(c(1, 2, 4, 3, 5, 6))
```

full	<i>Full symmetric matrix</i>
------	------------------------------

Description

Convert a column order distance matrix to a full symmetric matrix.

Usage

```
full(v)
```

Arguments

v lower-triangular column order distance matrix.

Details

Converts a column order lower-triangular distance matrix as written by R functions into a symmetric matrix. Note that `lower()` used on a 1x1 matrix will return the single element, which may not be the correct behavior in all cases, while `full()` used on a single element will return a 2x2 matrix.

Value

full symmetric matrix.

Author(s)

Sarah Goslee

See Also

[lower](#), [fixdmat](#)

Examples

```
# Given a vector:
x.vec <- seq_len(6)
x.vec

# Make an R-style column order symmetric matrix
full(x.vec)

# Extract the lower triangle from a symmetric matrix
# in column order
lower(full(x.vec))

# Convert to or from a row order symmetric matrix
fixdmat(x.vec)
lower(fixdmat(x.vec))

fixdmat(c(1, 2, 4, 3, 5, 6))
```

graze

Site information and grazed vegetation data.

Description

This data frame contains site location, landscape context and dominant plant species abundances for 25 of the plant species found in 50 grazed pastures in the northeastern United States. Elements are the mean values for canopy cover for ten 0.5 x 2 m quadrats.

Usage

```
data(graze)
```

Format

A data frame with 50 observations on the following 25 variables.

sitelocation Site location along a geographic gradient.

forestpct Percentage forest cover within a 1-km radius.

ACMI2 Percentage canopy cover.

ANOD Percentage canopy cover.

ASSY Percentage canopy cover.

BRIN2 Percentage canopy cover.

CIAR4 Percentage canopy cover.

CIIN Percentage canopy cover.

CIVU Percentage canopy cover.

DAGL Percentage canopy cover.

ELRE4 Percentage canopy cover.
GAM0 Percentage canopy cover.
LOAR10 Percentage canopy cover.
LOC06 Percentage canopy cover.
LOPE Percentage canopy cover.
OXST Percentage canopy cover.
PLMA2 Percentage canopy cover.
POPR Percentage canopy cover.
PRVU Percentage canopy cover.
RAAC3 Percentage canopy cover.
RUCR Percentage canopy cover.
SORU2 Percentage canopy cover.
STGR Percentage canopy cover.
TAOF Percentage canopy cover.
TRPR2 Percentage canopy cover.
TRRE3 Percentage canopy cover.
VEOF2 Percentage canopy cover.

Details

Site locations fall along a southwest-northeast transect through the northeastern United States. This is a synthetic gradient calculated from latitude and longitude. Forest landcover is taken from the USGS 1992 National Land Cover Dataset. All forest classes were combined, and the percentage within 1 km of the sample sites was calculated using a GIS.

Author(s)

Sarah Goslee

Source

Details of these data are available in Tracy and Sanderson (2000) and Goslee and Sanderson (2010). The 1992 NLCD data can be obtained from <http://www.mrlc.gov/>. Species codes are from <http://plants.usda.gov> (2010).

References

Tracy, B.F. and M.A. Sanderson. 2000. Patterns of plant species richness in pasture lands of the northeast United States. *Plant Ecology* 149:169-180.
Goslee, S.C., Sanderson, M.A. 2010. Landscape Context and Plant Community Composition in Grazed Agricultural Systems. *Landscape Ecology* 25:1029-1039.

Examples

```
data(graze)
```

iris.fit

*Example of adding to an ordination***Description**

A fitted ordination for use in the example for [addord](#). Many of the functions in `ecodist` take a long time to run, so prepared examples have been included.

Usage

```
data(iris.fit)
```

Format

The format of this object is a list with: `X1`, `X2`, etc: ordination configuration: coordinates for each point. `stress`: goodness of fit for each point. `isTrain`: logical vector indicating whether each point was used in the original ordination.

Author(s)

Sarah Goslee

See Also

[nmds](#), [addord](#)

Examples

```
data(iris)
iris.d <- dist(iris[,1:4])

### nmds() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.nmds <- nmds(iris.d, nits=20, mindim=1, maxdim=4)
### save(iris.nmds, file="ecodist/data/iris.nmds.rda")
data(iris.nmds)

# choose the best two-dimensional solution to work with
iris.nmin <- min(iris.nmds, dims=2)

# generate new data points to add to the ordination
# this might be new samples, or a second dataset

iris.new <- structure(list(Sepal.Length = c(4.6, 4.9, 5.4, 5.2, 6, 6.5, 6,
6.8, 7.3), Sepal.Width = c(3.2, 3.5, 3.6, 2.3, 2.8, 3, 2.7, 3.1,
3.2), Petal.Length = c(1.2, 1.5, 1.5, 3.5, 4.1, 4.2, 4.8, 5,
5.7), Petal.Width = c(0.26, 0.26, 0.26, 1.2, 1.3, 1.4, 1.8, 2,
2), Species = structure(c(1L, 1L, 1L, 2L, 2L, 2L, 3L, 3L, 3L), .Label = c("setosa",
```

```

"versicolor", "virginica"), class = "factor")), .Names = c("Sepal.Length",
"Sepal.Width", "Petal.Length", "Petal.Width", "Species"), class = "data.frame",
row.names = c(NA, -9L))

# provide a dist object containing original and new data
# provide a logical vector indicating which samples were used to
# construct the original configuration

iris.full <- rbind(iris, iris.new)
all.d <- dist(iris.full[,1:4])
is.orig <- c(rep(TRUE, nrow(iris)), rep(FALSE, nrow(iris.new)))

### addord() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.fit <- addord(iris.nmin, iris.full[,1:4], all.d, is.orig, maxit=100)
### save(iris.fit, file="ecodist/data/iris.fit.rda")
data(iris.fit)

plot(iris.fit$conf, col=iris.full$Species, pch=c(18, 4)[is.orig + 1],
     xlab="NMDS 1", ylab="NMDS 2")
title("Demo: adding points to an ordination")
legend("bottomleft", c("Training set", "Added point"), pch=c(4, 18))
legend("topright", levels(iris$Species), fill=1:3)

```

iris.nmnds

Example for nmnds

Description

An object of class `nmnds` for use in the example for `nmnds`. Many of the functions in `ecodist` take a long time to run, so prepared examples have been included.

Usage

```
data(iris.nmnds)
```

Format

See `nmnds` for current format specification.

Author(s)

Sarah Goslee

See Also

[nmnds](#)

Examples

```
data(iris)
iris.d <- dist(iris[,1:4])

### nmds() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.nmds <- nmds(iris.d, nits=20, mindim=1, maxdim=4)
### save(iris.nmds, file="ecodist/data/iris.nmds.rda")
data(iris.nmds)

# examine fit by number of dimensions
plot(iris.nmds)
```

iris.vf

Example for vector fitting on ordination

Description

An object of class `vf` for use in the examples for `nmds` and `vf`. Many of the functions in `ecodist` take a long time to run, so prepared examples have been included.

Usage

```
data(iris.vf)
```

Format

See `vf` for current format specification.

Author(s)

Sarah Goslee

See Also

`nmds`, `vf`

Examples

```
data(iris)
iris.d <- dist(iris[,1:4])

### nmds() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
```

```
### iris.nmnds <- nmnds(iris.d, nits=20, mindim=1, maxdim=4)
### save(iris.nmnds, file="ecodist/data/iris.nmnds.rda")
data(iris.nmnds)

# examine fit by number of dimensions
plot(iris.nmnds)

# choose the best two-dimensional solution to work with
iris.nmin <- min(iris.nmnds, dims=2)

# rotate the configuration to maximize variance
iris.rot <- princomp(iris.nmin)$scores

# rotation preserves distance apart in ordination space
cor(dist(iris.nmin), dist(iris.rot))

# fit the data to the ordination as vectors
### vf() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.vf <- vf(iris.nmin, iris[,1:4], nperm=1000)
### save(iris.vf, file="ecodist/data/iris.vf.rda")
data(iris.vf)

plot(iris.nmin, col=as.numeric(iris$Species), pch=as.numeric(iris$Species), main="NMDS")
plot(iris.vf)
```

iris.vfrot

Example for vector fitting on rotated ordination

Description

An object of class `vf` for use in the examples for `nmnds` and `vf`. Many of the functions in `ecodist` take a long time to run, so prepared examples have been included.

Usage

```
data(iris.vfrot)
```

Format

See `vf` for current format specification.

Author(s)

Sarah Goslee

See Also

`nmnds`, `vf`

Examples

```

data(iris)
iris.d <- dist(iris[,1:4])

### nmds() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.nmds <- nmds(iris.d, nits=20, mindim=1, maxdim=4)
### save(iris.nmds, file="ecodist/data/iris.nmds.rda")
data(iris.nmds)

# examine fit by number of dimensions
plot(iris.nmds)

# choose the best two-dimensional solution to work with
iris.nmin <- min(iris.nmds, dims=2)

# rotate the configuration to maximize variance
iris.rot <- princomp(iris.nmin)$scores

# rotation preserves distance apart in ordination space
cor(dist(iris.nmin), dist(iris.rot))

# fit the data to the ordination as vectors
### vf() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.vf <- vf(iris.nmin, iris[,1:4], nperm=1000)
### save(iris.vf, file="ecodist/data/iris.vf.rda")
data(iris.vf)

# repeat for the rotated ordination
### vf() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.vfrot <- vf(iris.rot, iris[,1:4], nperm=1000)
### save(iris.vfrot, file="ecodist/data/iris.vfrot.rda")
data(iris.vfrot)

par(mfrow=c(1,2))
plot(iris.nmin, col=as.numeric(iris$Species), pch=as.numeric(iris$Species), main="NMDS")
plot(iris.vf)
plot(iris.rot, col=as.numeric(iris$Species), pch=as.numeric(iris$Species), main="Rotated NMDS")
plot(iris.vfrot)

```

Description

Convert a symmetric distance matrix to a column order lower triangular matrix.

Usage

```
lower(m)
```

Arguments

`m` a symmetric distance matrix.

Details

Converts a symmetric matrix, for example a dissimilarity matrix, into a column order lower-triangular matrix. This may be useful to format the input for certain clustering and ordination functions. Note that `lower()` used on a 1x1 matrix will return the single element, which may not be the correct behavior in all cases, while `full()` used on a single element will return a 2x2 matrix.

Value

column order lower triangular matrix.

Author(s)

Sarah Goslee

See Also

[full](#), [fixdmat](#)

Examples

```
x.vec <- seq_len(6)
x.vec

# Make an R-style column order symmetric matrix
full(x.vec)

# Extract the lower triangle from a symmetric matrix
# in column order
lower(full(x.vec))

# Convert to or from a row order symmetric matrix
fixdmat(x.vec)
lower(fixdmat(x.vec))

fixdmat(c(1, 2, 4, 3, 5, 6))
```

mantel *Mantel test*

Description

Simple and partial Mantel tests, with options for ranked data, permutation tests, and bootstrapped confidence limits.

Usage

```
mantel(formula = formula(data), data = sys.parent(), nperm = 1000,
       mrank = FALSE, nboot = 500, pboot = 0.9, cboot = 0.95)
```

Arguments

formula	formula describing the test to be conducted. For this test, $y \sim x$ will perform a simple Mantel test, while $y \sim x + z1 + z2 + z3$ will do a partial Mantel test of the relationship between x and y given $z1$, $z2$, $z3$. All variables can be either a distance matrix of class <code>dist</code> or vectors of dissimilarities.
data	an optional dataframe containing the variables in the model as columns of dissimilarities. By default the variables are taken from the current environment.
nperm	number of permutations to use. If set to 0, the permutation test will be omitted.
mrnk	if this is set to <code>FALSE</code> (the default option), Pearson correlations will be used. If set to <code>TRUE</code> , the Spearman correlation (correlation ranked distances) will be used.
nboot	number of iterations to use for the bootstrapped confidence limits. If set to 0, the bootstrapping will be omitted.
pboot	the level at which to resample the data for the bootstrapping procedure.
cboot	the level of the confidence limits to estimate.

Details

If only one independent variable is given, the simple Mantel r (r_{12}) is calculated. If more than one independent variable is given, the partial Mantel r ($r_{y|x_1 \dots}$) is calculated by permuting one of the original dissimilarity matrices. The bootstrapping is actually resampling without replacement, because duplication of samples is not useful in a dissimilarity context (the dissimilarity of a sample with itself is zero). Resampling within dissimilarity values is inappropriate, just as for permutation.

Value

mantelr	Mantel coefficient.
pval1	one-tailed p-value (null hypothesis: $r \leq 0$).
pval2	one-tailed p-value (null hypothesis: $r \geq 0$).
pval3	two-tailed p-value (null hypothesis: $r = 0$).
llim	lower confidence limit.
ulim	upper confidence limit.

Author(s)

Sarah Goslee

References

Mantel, N. 1967. The detection of disease clustering and a generalized regression approach. *Cancer Research* 27:209-220.

Smouse, P.E., J.C. Long and R.R. Sokal. 1986. Multiple regression and correlation extensions of the Mantel test of matrix correspondence. *Systematic Zoology* 35:62 7-632.

Goslee, S.C. and Urban, D.L. 2007. The ecodist package for dissimilarity-based analysis of ecological data. *Journal of Statistical Software* 22(7):1-19.

Goslee, S.C. 2010. Correlation analysis of dissimilarity matrices. *Plant Ecology* 206(2):279-286.

See Also

[mgram](#), [mgroup](#)

Examples

```
data(graze)

grasses <- graze[, colnames(graze) %in% c("DAGL", "LOAR10", "LOPE", "POPR")]
legumes <- graze[, colnames(graze) %in% c("LOC06", "TRPR2", "TRRE3")]

grasses.bc <- bcdist(grasses)
legumes.bc <- bcdist(legumes)

space.d <- dist(graze$sitelocation)
forest.d <- dist(graze$forestpct)

# Mantel test: is the difference in forest cover between sites
# related to the difference in grass composition between sites?
mantel(grasses.bc ~ forest.d)

# Mantel test: is the geographic distance between sites
# related to the difference in grass composition between sites?
mantel(grasses.bc ~ space.d)

# Partial Mantel test: is the difference in forest cover between sites
# related to the difference in grass composition once the
# linear effects of geographic distance are removed?
mantel(grasses.bc ~ forest.d + space.d)

# Mantel test: is the difference in forest cover between sites
# related to the difference in legume composition between sites?
mantel(legumes.bc ~ forest.d)

# Mantel test: is the geographic distance between sites
```

```
# related to the difference in legume composition between sites?
mantel(legumes.bc ~ space.d)

# Partial Mantel test: is the difference in forest cover between sites
# related to the difference in legume composition once the
# linear effects of geographic distance are removed?
mantel(legumes.bc ~ forest.d + space.d)

# Is there nonlinear pattern in the relationship with geographic distance?
par(mfrow=c(2, 1))
plot(mgram(grasses.bc, space.d, nclass=8))
plot(mgram(legumes.bc, space.d, nclass=8))
```

mgram

Mantel correlogram

Description

Calculates simple Mantel correlograms.

Usage

```
mgram(species.d, space.d, breaks, nclass, stepsize, nperm = 1000,
      mrank = FALSE, nboot = 500, pboot = 0.9, cboot = 0.95,
      alternative = "two.sided", trace = FALSE)
```

Arguments

species.d	lower-triangular dissimilarity matrix.
space.d	lower-triangular matrix of geographic distances.
breaks	locations of class breaks. If specified, overrides nclass and stepsize.
nclass	number of distance classes. If not specified, Sturge's rule will be used to determine an appropriate number of classes.
stepsize	width of each distance class. If not specified, nclass and the range of space.d will be used to calculate an appropriate default.
nperm	number of permutations to use. If set to 0, the permutation test will be omitted.
mrnk	if this is set to FALSE (the default option), Pearson correlations will be used. If set to TRUE, the Spearman correlation (correlation ranked distances) will be used.
nboot	number of iterations to use for the bootstrapped confidence limits. If set to 0, the bootstrapping will be omitted.
pboot	the level at which to resample the data for the bootstrapping procedure.
cboot	the level of the confidence limits to estimate.
alternative	default is "two.sided", and returns p-values for $H_0: r_M = 0$. The alternative is "one.sided", which returns p-values for $H_0: r_M \leq 0$.
trace	if TRUE, returns progress indicators.

Details

This function calculates Mantel correlograms. The Mantel correlogram is essentially a multivariate autocorrelation function. The Mantel r represents the dissimilarity in variable composition (often species composition) at a particular lag distance.

Value

Returns an object of class `mgram`, which is a list with two elements. `mgram` is a matrix with one row for each distance class and 6 columns:

<code>lag</code>	midpoint of the distance class.
<code>ngroup</code>	number of distances in that class.
<code>mantelr</code>	Mantel r value.
<code>pval</code>	p-value for the test chosen.
<code>llim</code>	lower bound of confidence limit for mantelr.
<code>ulim</code>	upper bound of confidence limit for mantelr.

`resids` is NA for objects calculated by `mgram()`.

Author(s)

Sarah Goslee

References

Legendre, P. and M. Fortin. 1989. Spatial pattern and ecological analysis. *Vegetatio* 80:107-138.

See Also

[mantel](#), [plot.mgram](#), [pmgram](#)

Examples

```
# generate a simple surface
x <- matrix(1:10, nrow=10, ncol=10, byrow=FALSE)
y <- matrix(1:10, nrow=10, ncol=10, byrow=TRUE)
z <- x + 3*y
image(z)

# analyze the pattern of z across space
space <- cbind(as.vector(x), as.vector(y))
z <- as.vector(z)
space.d <- distance(space, "eucl")
z.d <- distance(z, "eucl")
z.mgram <- mgram(z.d, space.d, nperm=0)
plot(z.mgram)

#
```

```

data(graze)
space.d <- dist(graze$sitelocation)
forest.d <- dist(graze$forestpct)

grasses <- graze[, colnames(graze) %in% c("DAGL", "LOAR10", "LOPE", "POPR")]
legumes <- graze[, colnames(graze) %in% c("LOC06", "TRPR2", "TRRE3")]

grasses.bc <- bcdist(grasses)
legumes.bc <- bcdist(legumes)

# Does the relationship of composition with distance vary for
# grasses and legumes?
par(mfrow=c(2, 1))
plot(mgram(grasses.bc, space.d, nclass=8))
plot(mgram(legumes.bc, space.d, nclass=8))

```

mgroup

Mantel test for groups

Description

Simple and partial Mantel tests, with options for ranked data, permutation tests, and bootstrapped confidence limits.

Usage

```
mgroup(edist, groups, nperm=1000)
```

Arguments

edist	a dist object or lower triangular distance vector.
groups	a vector of group memberships (numeric, character, or factor), or a matrix or data frame with columns describing multiple sets of groups.
nperm	number of permutations to use. If set to 0, the permutation test will be omitted.

Details

mgroup returns the Mantel correlations for group contrast matrices computed from cluster groups across a range of clustering levels.

Value

nclust	Number of groups tested.
mantelr	Mantel coefficient.
pval1	one-tailed p-value (null hypothesis: $r \leq 0$).

Author(s)

Sarah Goslee

ReferencesLegendre, P. and M. Fortin. 1989. Spatial pattern and ecological analysis. *Vegetatio* 80:107-138.**See Also**[mantel](#)**Examples**

```
# Using a model matrix to test group membership

data(iris)
iris.d <- dist(iris[,1:4])
mgroup(iris.d, iris[,5])

# clustering-based example

data(graze)
graze.d <- dist(graze[, -c(1:2)])
graze.hclust <- hclust(graze.d)

clust.groups <- data.frame(
  k2 = cutree(graze.hclust, k = 2),
  k4 = cutree(graze.hclust, k = 4),
  k6 = cutree(graze.hclust, k = 6),
  k8 = cutree(graze.hclust, k = 8))

mgroup(graze.d, clust.groups, nperm=1000)
```

`min.nmnds`*Find minimum stress configuration*

DescriptionFinds minimum stress configuration from output of `nmnds()`**Usage**

```
## S3 method for class 'nmnds'
min(..., na.rm = FALSE, dims = 2)
nmnds.min(x, dims = 2)
```

Arguments

...	output from nmnds()
x	output from nmnds()
dims	desired dimensionality of result. If <code>dims = 0</code> then the overall minimum stress configuration is chosen. By default, the best two-dimensional configuration is returned.
na.rm	Not used; there should be no NA values in a NMDS configuration.

Details

For back-compatibility, the `nmnds.min` function remains.

Value

Configuration of minimum stress ordination (dataframe of coordinates). The stress and r^2 for the minimum stress configuration are stored as attributes.

Author(s)

Sarah Goslee

See Also

[nmnds](#)

Examples

```
data(iris)
iris.d <- dist(iris[,1:4])

### nmnds() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.nmnds <- nmnds(iris.d, nits=20, mindim=1, maxdim=4)
### save(iris.nmnds, file="ecodist/data/iris.nmnds.rda")
data(iris.nmnds)

# examine fit by number of dimensions
plot(iris.nmnds)

# choose the best two-dimensional solution to work with
iris.nmin <- min(iris.nmnds, dims=2)
```

Description

Multiple regression on distance matrices (MRM) using permutation tests of significance for regression coefficients and R-squared.

Usage

```
MRM(formula = formula(data), data = sys.parent(), nperm = 1000,
method = "linear", mrank = FALSE)
```

Arguments

formula	formula describing the test to be conducted.
data	an optional dataframe containing the variables in the model as columns of dissimilarities. By default the variables are taken from the current environment.
nperm	number of permutations to use. If set to 0, the permutation test will be omitted.
mrank	if this is set to FALSE (the default option), Pearson correlations will be used. If set to TRUE, the Spearman correlation (correlation ranked distances) will be used.
method	if "linear", the default, uses multiple regression analysis. If "logistic", performs logistic regression with appropriate permutation testing. Note that this may be substantially slower.

Details

Performs multiple regression on distance matrices following the methods outlined in Legendre et al. 1994. Specifically, the permutation test uses a pseudo-t test to assess significance, rather than using the regression coefficients directly.

Value

coef	A matrix with regression coefficients and associated p-values from the permutation test (using the pseudo-t of Legendre et al. 1994).
r.squared	Regression R-squared and associated p-value from the permutation test (linear only).
F.test	F-statistic and p-value for overall F-test for lack of fit (linear only).
dev	Residual deviance, degrees of freedom, and associated p-value (logistic only).

Author(s)

Sarah Goslee

References

- Lichstein, J. 2007. Multiple regression on distance matrices: A multivariate spatial analysis tool. *Plant Ecology* 188: 117-131.
- Legendre, P.; Lapointe, F. and Casgrain, P. 1994. Modeling brain evolution from behavior: A permutational regression approach. *Evolution* 48: 1487-1499.

See Also

[mantel](#)

Examples

```
data(graze)

# Abundance of this grass is related to forest cover but not location
MRM(dist(LOAR10) ~ dist(sitelocation) + dist(forestpct), data=graze, nperm=10)

# Abundance of this legume is related to location but not forest cover
MRM(dist(TRRE3) ~ dist(sitelocation) + dist(forestpct), data=graze, nperm=10)

# Compare to presence/absence of grass LOAR10 using logistic regression
LOAR10.presence <- ifelse(graze$LOAR10 > 0, 1, 0)
MRM(dist(LOAR10.presence) ~ dist(sitelocation) + dist(forestpct),
     data=graze, nperm=10, method="logistic")
```

nmds

Non-metric multidimensional scaling

Description

Non-metric multidimensional scaling.

Usage

```
nmds(dmat, mindim = 1, maxdim = 2, nits = 10, iconf, epsilon = 1e-12,
     maxit = 500, trace = FALSE)
```

Arguments

dmat	lower-triangular dissimilarity matrix.
mindim	optional, minimum number of dimensions to use.
maxdim	optional, maximum number of dimensions to use.
nits	optional, number of separate ordinations to use.
iconf	optional, initial configuration. If not specified, then a random configuration is used.

epsilon	optional, acceptable difference in stress.
maxit	optional, maximum number of iterations.
trace	if TRUE, will write progress indicator to the screen.

Details

The goal of NMDS is to find a configuration in a given number of dimensions which preserves rank-order dissimilarities as closely as possible. The number of dimensions must be specified in advance. Because NMDS is prone to finding local minima, several random starts must be used. Stress is used as the measure of goodness of fit. A lower stress indicates a better match between dissimilarity and ordination. As of ecodist 1.9, the stress calculation used is the same as in MASS: `isoMDS`. In previous versions it was monotonically related, so the same configurations were produced, but the absolute value was different.

Value

conf	list of configurations.
stress	list of final stress values.
r2	total variance explained by each configuration.

The first results are for the lowest number of dimensions (total number is $(\text{mindim} - \text{maxdim} + 1) * \text{nits}$).

Author(s)

Sarah Goslee

References

- Kruskal, J.B. 1964. Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis. *Psychometrika* 29:1-27.
- Minchin, P.R. 1987. An evaluation of the relative robustness of techniques for ecological ordination. *Vegetatio* 96:89-108.

See Also

[plot.nmds](#), [min.nmds](#), [vf](#), [addord](#)

Examples

```
data(iris)
iris.d <- dist(iris[,1:4])

### nmds() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.nmds <- nmds(iris.d, nits=20, mindim=1, maxdim=4)
### save(iris.nmds, file="ecodist/data/iris.nmds.rda")
data(iris.nmds)
```

```

# examine fit by number of dimensions
plot(iris.nmds)

# choose the best two-dimensional solution to work with
iris.nmin <- min(iris.nmds, dims=2)

# rotate the configuration to maximize variance
iris.rot <- princomp(iris.nmin)$scores

# rotation preserves distance apart in ordination space
cor(dist(iris.nmin), dist(iris.rot))

# fit the data to the ordination as vectors
### vf() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.vf <- vf(iris.nmin, iris[,1:4], nperm=1000)
### save(iris.vf, file="ecodist/data/iris.vf.rda")
data(iris.vf)

# repeat for the rotated ordination
### vf() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.vfrot <- vf(iris.rot, iris[,1:4], nperm=1000)
### save(iris.vfrot, file="ecodist/data/iris.vfrot.rda")
data(iris.vfrot)

par(mfrow=c(1,2))
plot(iris.nmin, col=as.numeric(iris$Species), pch=as.numeric(iris$Species), main="NMDS")
plot(iris.vf)
plot(iris.rot, col=as.numeric(iris$Species), pch=as.numeric(iris$Species),
     main="Rotated NMDS")
plot(iris.vfrot)

# generate new data points to add to the ordination
# this might be new samples, or a second dataset

iris.new <- structure(list(Sepal.Length = c(4.6, 4.9, 5.4, 5.2, 6, 6.5, 6,
6.8, 7.3), Sepal.Width = c(3.2, 3.5, 3.6, 2.3, 2.8, 3, 2.7, 3.1,
3.2), Petal.Length = c(1.2, 1.5, 1.5, 3.5, 4.1, 4.2, 4.8, 5,
5.7), Petal.Width = c(0.26, 0.26, 0.26, 1.2, 1.3, 1.4, 1.8, 2,
2), Species = structure(c(1L, 1L, 1L, 2L, 2L, 2L, 3L, 3L, 3L), .Label = c("setosa",
"versicolor", "virginica"), class = "factor")), .Names = c("Sepal.Length",
"Sepal.Width", "Petal.Length", "Petal.Width", "Species"), class = "data.frame",
row.names = c(NA, -9L))

# provide a dist object containing original and new data
# provide a logical vector indicating which samples were used to
# construct the original configuration

iris.full <- rbind(iris, iris.new)

```

```

all.d <- dist(iris.full[,1:4])
is.orig <- c(rep(TRUE, nrow(iris)), rep(FALSE, nrow(iris.new)))

### addord() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.fit <- addord(iris.nmin, iris.full[,1:4], all.d, is.orig, maxit=100)
### save(iris.fit, file="ecodist/data/iris.fit.rda")
data(iris.fit)

plot(iris.fit$conf, col=iris.full$Species, pch=c(18, 4)[is.orig + 1],
     xlab="NMDS 1", ylab="NMDS 2")
title("Demo: adding points to an ordination")
legend("bottomleft", c("Training set", "Added point"), pch=c(4, 18))
legend("topright", levels(iris$Species), fill=1:3)

```

pco

*Principal coordinates analysis***Description**

Principal coordinates analysis (classical scaling).

Usage

```
pco(x, negvals = "zero", dround = 0)
```

Arguments

x	a lower-triangular dissimilarity matrix.
negvals	if = "zero" sets all negative eigenvalues to zero; if = "rm" corrects for negative eigenvalues using method 1 of Legendre and Anderson 1999.
dround	if greater than 0, attempts to correct for round-off error by rounding to that number of places.

Details

PCO (classical scaling, metric multidimensional scaling) is very similar to principal components analysis, but allows the use of any dissimilarity metric.

Value

values	eigenvalue for each component. This is a measure of the variance explained by each dimension.
vectors	eigenvectors. Each column contains the scores for that dimension.

Author(s)

Sarah Goslee

See Also[princomp](#), [nmds](#)**Examples**

```
data(iris)
iris.d <- dist(iris[,1:4])
iris.pco <- pco(iris.d)

# scatterplot of the first two dimensions
plot(iris.pco$vectors[,1:2], col=as.numeric(iris$Species),
     pch=as.numeric(iris$Species), main="PCO", xlab="PCO 1", ylab="PCO 2")
```

`plot.mgram`*Plot a Mantel correlogram*

Description

Plot a Mantel correlogram from an object of S3 class `mgram`, using solid symbols for significant values.

Usage

```
## S3 method for class 'mgram'
plot(x, pval = 0.05, xlab = "Distance", ylab = "Mantel r", ...)
```

Arguments

<code>x</code>	an object of class <code>mgram</code>
<code>pval</code>	cut-off level for statistical significance.
<code>xlab</code>	x-axis label.
<code>ylab</code>	y-axis label.
<code>...</code>	optional, any additional graphics parameters.

Value

draws a plot (graphics device must be active).

Author(s)

Sarah Goslee

See Also[mgram](#)

Examples

```

# generate a simple surface
x <- matrix(1:10, nrow=10, ncol=10, byrow=FALSE)
y <- matrix(1:10, nrow=10, ncol=10, byrow=TRUE)
z <- x + 3*y
image(z)

# analyze the pattern of z across space
space <- cbind(as.vector(x), as.vector(y))
z <- as.vector(z)
space.d <- distance(space, "eucl")
z.d <- distance(z, "eucl")
z.mgram <- mgram(z.d, space.d, nperm=0)
plot(z.mgram)

#

data(graze)
space.d <- dist(graze$siteLocation)
forest.d <- dist(graze$forestpct)

grasses <- graze[, colnames(graze) %in% c("DAGL", "LOAR10", "LOPE", "POPR")]
legumes <- graze[, colnames(graze) %in% c("LOC06", "TRPR2", "TRRE3")]

grasses.bc <- bcdist(grasses)
legumes.bc <- bcdist(legumes)

# Does the relationship of composition with distance vary for
# grasses and legumes?
par(mfrow=c(2, 1))
plot(mgram(grasses.bc, space.d, nclass=8))
plot(mgram(legumes.bc, space.d, nclass=8))

```

plot.nmnds

Plot information about NMDS ordination

Description

Graphical display of stress and r2 for NMDS ordination along number of dimensions.

Usage

```

## S3 method for class 'nmnds'
plot(x, plot = TRUE, xlab = "Dimensions", ...)

```

Arguments

x an object of S3 class nmds, created by nmds()
plot optional, if TRUE a figure is produced
xlab optional, label for x axis of graph
... optional, other graphics parameters

Value

Produces a two-panel plot with stress and r2 for ordination by number of dimensions. Points show the mean value; lines indicate minimum and maximum.

Author(s)

Dean Urban

See Also

[nmds](#)

Examples

```
data(iris)
iris.d <- dist(iris[,1:4])

### nmds() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.nmds <- nmds(iris.d, nits=20, mindim=1, maxdim=4)
### save(iris.nmds, file="ecodist/data/iris.nmds.rda")
data(iris.nmds)

# examine fit by number of dimensions
plot(iris.nmds)

# choose the best two-dimensional solution to work with
iris.nmin <- min(iris.nmds, dims=2)
```

plot.vf

Plots fitted vectors onto an ordination diagram

Description

Add vector fitting arrows to an existing ordination plot.

Usage

```
## S3 method for class 'vf'
plot(x, pval = 1, cex = 0.8, ascale = 0.9, ...)
```

Arguments

x	an object of S3 class vf, created by vf()
pval	optional, critical p-value for choosing variables to plot
cex	text size
ascale	optional, proportion of plot area to use when calculating arrow length
...	optional, other graphics parameters

Value

Adds arrows to an existing ordination plot. Only arrows with a p-value less than pval are added. By default, all variables are shown.

Author(s)

Sarah Goslee

See Also

[vf](#)

Examples

```
# Example of multivariate analysis using built-in iris dataset
data(iris)
iris.d <- dist(iris[,1:4])

### nmds() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.nmds <- nmds(iris.d, nits=20, mindim=1, maxdim=4)
### save(iris.nmds, file="ecodist/data/iris.nmds.rda")
data(iris.nmds)

# examine fit by number of dimensions
plot(iris.nmds)

# choose the best two-dimensional solution to work with
iris.nmin <- min(iris.nmds, dims=2)

# fit the data to the ordination as vectors
### vf() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.vf <- vf(iris.nmin, iris[,1:4], nperm=1000)
```

```
### save(iris.vf, file="ecodist/data/iris.vf.rda")
data(iris.vf)
plot(iris.nmin, col=as.numeric(iris$Species), pch=as.numeric(iris$Species), main="NMDS")
plot(iris.vf)
```

pmgram

Partial Mantel correlogram

Description

This function calculates simple and partial multivariate correlograms.

Usage

```
pmgram(data, space, partial, breaks, nclass, stepsize, resid = FALSE, nperm = 1000)
```

Arguments

data	lower-triangular dissimilarity matrix. This can be either an object of class <code>dist</code> (treated as one column) or a matrix or data frame with one or two columns, each of which is an independent lower-triangular dissimilarity in vector form.
space	lower-triangular matrix of geographic distances.
partial	optional, lower-triangular dissimilarity matrix of ancillary data.
breaks	locations of class breaks. If specified, overrides <code>nclass</code> and <code>stepsize</code> .
nclass	number of distance classes. If not specified, Sturge's rule will be used to determine an appropriate number of classes.
stepsize	width of each distance class. If not specified, <code>nclass</code> and the range of <code>space</code> will be used to calculate an appropriate default.
resid	if <code>resid=TRUE</code> , will return the residuals for each distance class. Otherwise returns 0.
nperm	number of permutations to use. If set to 0, the permutation test will be omitted.

Details

This function does four different analyses: If data has 1 column and `partial` is missing, calculates a multivariate correlogram for data.

If data has 2 columns and `partial` is missing, calculates a Mantel cross-correlogram, calculating the Mantel r between the two columns for each distance class separately.

If data has 1 column and `partial` exists, calculates a partial multivariate correlogram based on residuals of `data ~ partial`.

If data has 2 columns and `partial` exists, does a partial Mantel cross-correlogram, calculating partial Mantel r for each distance class separately.

The `Iwt` statistic used for the multivariate correlograms is not the standard Mantel r . For one variable, using Euclidean distance, this metric converges on the familiar Moran autocorrelation. Like

the Moran autocorrelation function, this statistic usually falls between -1 and 1, but is not bounded by those limits. Unlike the Moran function, this correlogram can be used for multivariate data, and can be extended to partial tests.

The comparisons in `vignette("dissimilarity", package="ecodist")` may help.

Value

Returns a object of class `mgram`, which is a list containing two objects: `mgram` is a matrix with one row for each distance class and 4 columns:

<code>lag</code>	midpoint of the distance class.
<code>ngroup</code>	number of distances in that class.
<code>piecer</code> or <code>Iwt</code>	Mantel r value or appropriate statistic (see Details).
<code>pval</code>	two-sided p-value.

`resids` is a vector of the residuals (if calculated) and can be accessed with the `residuals()` method.

Author(s)

Sarah Goslee

See Also

[mgram](#), [mantel](#), [residuals.mgram](#), [plot.mgram](#)

Examples

```
data(bump)

par(mfrow=c(1, 2))
image(bump, col=gray(seq(0, 1, length=5)))

z <- as.vector(bump)
x <- rep(1:25, times=25)
y <- rep(1:25, each=25)

X <- col(bump)
Y <- row(bump)
# calculate dissimilarities for data and space
geo.dist <- dist(cbind(as.vector(X), as.vector(Y)))
value.dist <- dist(as.vector(bump))

### pmgram() is time-consuming, so this was generated
### in advance and saved.
### set.seed(1234)
### bump.pmgram <- pmgram(value.dist, geo.dist, nperm=10000)

data(bump.pmgram)
plot(bump.pmgram)
```

```

#### Partial pmgram example

# generate a simple surface
# with complex nonlinear spatial pattern

x <- matrix(1:25, nrow=25, ncol=25, byrow=FALSE)
y <- matrix(1:25, nrow=25, ncol=25, byrow=TRUE)

# create z1 and z2 as functions of x, y
# and scale them to [0, 1]
z1 <- x + 3*y
z2 <- y - cos(x)

z1 <- (z1 - min(z1)) / (max(z1) - min(z1))
z2 <- (z2 - min(z2)) / (max(z2) - min(z2))

z12 <- (z1 + z2*2)/3

# look at patterns

layout(matrix(c(
1, 1, 2, 2,
1, 1, 2, 2,
3, 3, 4, 4,
3, 3, 5, 5), nrow=4, byrow=TRUE))

image(z1, col=gray(seq(0, 1, length=20)), zlim=c(0,1))
image(z2, col=gray(seq(0, 1, length=20)), zlim=c(0,1))
image(z12, col=gray(seq(0, 1, length=20)), zlim=c(0,1))

# analyze the pattern of z across space
z1 <- as.vector(z1)
z2 <- as.vector(z2)
z12 <- as.vector(z12)
z1.d <- dist(z1)
z2.d <- dist(z2)
z12.d <- dist(z12)

space <- cbind(as.vector(x), as.vector(y))
space.d <- dist(space)

# take partial correlogram without effects of z1
### pmgram() is time-consuming, so this was generated
### in advance and saved.
### set.seed(1234)
### z.no <- pmgram(z12.d, space.d, nperm=1000, resid=FALSE)
### save(z.no, file="ecodist/data/z.no.rda")
data(z.no)
plot(z.no)

# take partial correlogram of z12 given z1

```

```
### pmgram() is time-consuming, so this was generated
### in advance and saved.
### set.seed(1234)
### z.z1 <- pmgram(z12.d, space.d, z2.d, nperm=1000, resid=FALSE)
### save(z.z1, file="ecodist/data/z.z1.rda")
data(z.z1)
plot(z.z1)
```

residuals.mgram

Residuals of a Mantel correlogram

Description

Extracts residuals from an S3 object of class `mgram` (only relevant for objects created by `pmgram{ }`).

Usage

```
## S3 method for class 'mgram'
residuals(object, ...)
```

Arguments

<code>object</code>	an object of class <code>mgram</code>
<code>...</code>	additional arguments

Value

vector of residuals.

Author(s)

Sarah Goslee

See Also

[pmgram](#), [mgram](#)

Examples

```
#### Partial pmgram example

# generate a simple surface
# with complex nonlinear spatial pattern

x <- matrix(1:10, nrow=10, ncol=10, byrow=FALSE)
y <- matrix(1:10, nrow=10, ncol=10, byrow=TRUE)
```

```

# create z1 and z2 as functions of x, y
# and scale them to [0, 1]
z1 <- x + 3*y
z2 <- y - cos(x)

z1 <- (z1 - min(z1)) / (max(z1) - min(z1))
z2 <- (z2 - min(z2)) / (max(z2) - min(z2))

z12 <- (z1 + z2*2)/3

# analyze the pattern of z across space
z1 <- as.vector(z1)
z2 <- as.vector(z2)
z12 <- as.vector(z12)
z1.d <- dist(z1)
z2.d <- dist(z2)
z12.d <- dist(z12)

space <- cbind(as.vector(x), as.vector(y))
space.d <- dist(space)

# take partial correlogram of z12 given z1
z.z1 <- pmgram(z12.d, space.d, z2.d, nperm=0, resid=TRUE)
summary(residuals(z.z1))

```

 vf

Vector fitting

Description

Fits ancillary variables to an ordination configuration.

Usage

```
vf(ord, vars, nperm = 100)
```

Arguments

ord	matrix containing a 2-dimensional ordination result with axes as columns.
vars	matrix with ancillary variables as columns.
nperm	number of permutation for the significance test. If nperm = 0, the test will be omitted.

Details

Vector fitting finds the maximum correlation of the individual variables with a configuration of samples in ordination space.

Value

an object of class `vf` containing matrix with the first 2 columns containing the scores for every variable in each of the 2 dimensions of the ordination space. `r` is the maximum correlation of the variable with the ordination space, and `pval` is the result of the permutation test.

Author(s)

Sarah Goslee

References

Jongman, R.H.G., C.J.F. ter Braak and O.F.R. van Tongeren. 1995. Data analysis in community and landscape ecology. Cambridge University Press, New York.

See Also

[plot.vf](#)

Examples

```
# Example of multivariate analysis using built-in iris dataset
data(iris)
iris.d <- dist(iris[,1:4])

### nmds() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.nmds <- nmds(iris.d, nits=20, mindim=1, maxdim=4)
### save(iris.nmds, file="ecodist/data/iris.nmds.rda")
data(iris.nmds)

# examine fit by number of dimensions
plot(iris.nmds)

# choose the best two-dimensional solution to work with
iris.nmin <- min(iris.nmds, dims=2)

# fit the data to the ordination as vectors
### vf() is timeconsuming, so this was generated
### in advance and saved.
### set.seed(1234)
### iris.vf <- vf(iris.nmin, iris[,1:4], nperm=1000)
### save(iris.vf, file="ecodist/data/iris.vf.rda")
data(iris.vf)
plot(iris.nmin, col=as.numeric(iris$Species), pch=as.numeric(iris$Species), main="NMDS")
plot(iris.vf)
```

xdistance	<i>Cross-distance between two datasets.</i>
-----------	---

Description

Pairwise dissimilarity calculation between rows of one dataset and rows of another, for instance across different sampling periods for the same set of sites.

Usage

```
xdistance(x, y, method = "euclidean")
```

Arguments

x	A site by species or other matrix or data frame.
y	A a second site by species dataset, which must have at least the same columns.
method	This function calls distance to do the calculations, and will accept any method used there, currently: "euclidean", "bray-curtis", "manhattan", "mahalanobis" (squared Mahalanobis distance), "jaccard", "difference", "sorensen", "gower", "modgower10" (modified Gower, base 10), "modgower2" (modified Gower, base 2). Partial matching will work for selecting a method.

Details

This function will calculate rowwise dissimilarities between any pair of matrices or data frames with the same number of columns. Note that the cross-dissimilarity functions are for research purposes, and are not well-tested.

Value

A non-symmetric and possibly not square matrix of dissimilarities of class `xdist`, where `result <- xdistance(x,y)` produces a matrix with `result[a,b]` containing the dissimilarity between `x[a,]` and `y[b,]`.

Author(s)

Sarah Goslee

See Also

[distance](#), [xmantel](#), [xmgram](#)

Examples

```

data(graze)

### EXAMPLE 1: Square matrices

# take two subsets of sites with different dominant grass abundances
# use cut-offs that produce equal numbers of sites
dom1 <- subset(graze, POPR > 50 & DAGL < 20) # 8 sites
dom2 <- subset(graze, POPR < 50 & DAGL > 20) # 8 sites

# first two columns are site info
dom.xd <- xdistance(dom1[, -c(1,2)], dom2[, -c(1,2)], "bray")

# environmental and spatial distances; preserve rownames
forest.xd <- xdistance(dom1[, "forestpct", drop=FALSE],
  dom2[, "forestpct", drop=FALSE])
sitelocation.xd <- xdistance(dom1[, "sitelocation", drop=FALSE],
  dom2[, "sitelocation", drop=FALSE])

# permutes rows and columns of full nonsymmetric matrix
xmantel(dom.xd ~ forest.xd)
xmantel(dom.xd ~ forest.xd + sitelocation.xd)

plot(xmgram(dom.xd, sitelocation.xd))

### EXAMPLE 2: Non-square matrices

# take two subsets of sites with different dominant grass abundances
# this produces a non-square matrix

dom1 <- subset(graze, POPR > 45 & DAGL < 20) # 13 sites
dom2 <- subset(graze, POPR < 45 & DAGL > 20) # 8 sites

# first two columns are site info
dom.xd <- xdistance(dom1[, -c(1,2)], dom2[, -c(1,2)], "bray")

# environmental and spatial distances; preserve rownames
forest.xd <- xdistance(dom1[, "forestpct", drop=FALSE],
  dom2[, "forestpct", drop=FALSE])
sitelocation.xd <- xdistance(dom1[, "sitelocation", drop=FALSE],
  dom2[, "sitelocation", drop=FALSE])

# permutes rows and columns of full nonsymmetric matrix
xmantel(dom.xd ~ forest.xd, dims=c(13, 8))
xmantel(dom.xd ~ forest.xd + sitelocation.xd, dims=c(13, 8))

plot(xmgram(dom.xd, sitelocation.xd))

```

Description

Simple and partial cross-Mantel tests, with options for ranked data and permutation tests.

Usage

```
xmantel(formula = formula(data), data = sys.parent(), dims = NA,
        nperm = 1000, mrank = FALSE)
```

Arguments

formula	formula describing the test to be conducted. For this test, $y \sim x$ will perform a simple Mantel test, while $y \sim x + z1 + z2 + z3$ will do a partial Mantel test of the relationship between x and y given $z1, z2, z3$. All variables should be either non-symmetric square cross-dissimilarity matrices of class <code>xdist</code> , or vector forms thereof.
data	an optional dataframe containing the variables in the model as columns of dissimilarities. By default the variables are taken from the current environment.
dims	if the dissimilarity matrices are not square, the dimensions must be provided as <code>c(nrow, ncol)</code>
nperm	number of permutations to use. If set to 0, the permutation test will be omitted.
mrnk	if this is set to <code>FALSE</code> (the default option), Pearson correlations will be used. If set to <code>TRUE</code> , the Spearman correlation (correlation ranked distances) will be used.

Details

If only one independent variable is given, the simple Mantel r (r_{12}) is calculated. If more than one independent variable is given, the partial Mantel r ($r_{yx|x1 \dots}$) is calculated by permuting one of the original dissimilarity matrices. Note that the cross-dissimilarity functions are for research purposes, and are not well-tested.

Value

mantelr	Mantel coefficient.
pval1	one-tailed p-value (null hypothesis: $r \leq 0$).
pval2	one-tailed p-value (null hypothesis: $r \geq 0$).
pval3	two-tailed p-value (null hypothesis: $r = 0$).

Author(s)

Sarah Goslee

See Also

[xdistance](#), [xmgram](#)

Examples

```

data(graze)

### EXAMPLE 1: Square matrices

# take two subsets of sites with different dominant grass abundances
# use cut-offs that produce equal numbers of sites
dom1 <- subset(graze, POPR > 50 & DAGL < 20) # 8 sites
dom2 <- subset(graze, POPR < 50 & DAGL > 20) # 8 sites

# first two columns are site info
dom.xd <- xdistance(dom1[, -c(1,2)], dom2[, -c(1,2)], "bray")

# environmental and spatial distances; preserve rownames
forest.xd <- xdistance(dom1[, "forestpct", drop=FALSE],
  dom2[, "forestpct", drop=FALSE])
sitelocation.xd <- xdistance(dom1[, "sitelocation", drop=FALSE],
  dom2[, "sitelocation", drop=FALSE])

# permutes rows and columns of full nonsymmetric matrix
xmantel(dom.xd ~ forest.xd)
xmantel(dom.xd ~ forest.xd + sitelocation.xd)

plot(xmgram(dom.xd, sitelocation.xd))

### EXAMPLE 2: Non-square matrices

# take two subsets of sites with different dominant grass abundances
# this produces a non-square matrix

dom1 <- subset(graze, POPR > 45 & DAGL < 20) # 13 sites
dom2 <- subset(graze, POPR < 45 & DAGL > 20) # 8 sites

# first two columns are site info
dom.xd <- xdistance(dom1[, -c(1,2)], dom2[, -c(1,2)], "bray")

# environmental and spatial distances; preserve rownames
forest.xd <- xdistance(dom1[, "forestpct", drop=FALSE],
  dom2[, "forestpct", drop=FALSE])
sitelocation.xd <- xdistance(dom1[, "sitelocation", drop=FALSE],
  dom2[, "sitelocation", drop=FALSE])

# permutes rows and columns of full nonsymmetric matrix
xmantel(dom.xd ~ forest.xd, dims=c(13, 8))
xmantel(dom.xd ~ forest.xd + sitelocation.xd, dims=c(13, 8))

plot(xmgram(dom.xd, sitelocation.xd))

```

Description

Calculates simple Mantel correlograms from cross-distance matrices.

Usage

```
xmgram(species.xd, space.xd, breaks, nclass, stepsize, nperm = 1000,
        mrank = FALSE, alternative = "two.sided", trace = FALSE)
```

Arguments

species.xd	non-symmetric square cross-distance matrix.
space.xd	non-symmetric square matrix of geographic distances.
breaks	locations of class breaks. If specified, overrides nclass and stepsize.
nclass	number of distance classes. If not specified, Sturge's rule will be used to determine an appropriate number of classes.
stepsize	width of each distance class. If not specified, nclass and the range of space.d will be used to calculate an appropriate default.
nperm	number of permutations to use. If set to 0, the permutation test will be omitted.
mrnk	if this is set to FALSE (the default option), Pearson correlations will be used. If set to TRUE, the Spearman correlation (correlation ranked distances) will be used.
alternative	default is "two.sided", and returns p-values for H0: $r_M = 0$. The alternative is "one.sided", which returns p-values for H0: $r_M \leq 0$.
trace	if TRUE, returns progress indicators.

Details

This function calculates cross-Mantel correlograms. The Mantel correlogram is essentially a multivariate autocorrelation function. The Mantel r represents the dissimilarity in variable composition (often species composition) at a particular lag distance. Note that the cross-dissimilarity functions are for research purposes, and are not well-tested.

Value

Returns an object of class `mgram`, which is a list with two elements. `mgram` is a matrix with one row for each distance class and 6 columns:

lag	midpoint of the distance class.
ngroup	number of distances in that class.
mantelr	Mantel r value.
pval	p-value for the test chosen.

resids is NA for objects calculated by `mgram()`.

Author(s)

Sarah Goslee

References

Legendre, P. and M. Fortin. 1989. Spatial pattern and ecological analysis. *Vegetatio* 80:107-138.

See Also

[xdistance](#) [xmantel](#), [plot.mgram](#)

Examples

```
# Need to develop a cross-dissimilarity example
data(graze)

### EXAMPLE 1: Square matrices

# take two subsets of sites with different dominant grass abundances
# use cut-offs that produce equal numbers of sites
dom1 <- subset(graze, POPR > 50 & DAGL < 20) # 8 sites
dom2 <- subset(graze, POPR < 50 & DAGL > 20) # 8 sites

# first two columns are site info
dom.xd <- xdistance(dom1[, -c(1,2)], dom2[, -c(1,2)], "bray")

# environmental and spatial distances; preserve rownames
forest.xd <- xdistance(dom1[, "forestpct", drop=FALSE],
  dom2[, "forestpct", drop=FALSE])
sitelocation.xd <- xdistance(dom1[, "sitelocation", drop=FALSE],
  dom2[, "sitelocation", drop=FALSE])

# permutes rows and columns of full nonsymmetric matrix
xmantel(dom.xd ~ forest.xd)
xmantel(dom.xd ~ forest.xd + sitelocation.xd)

plot(xmgram(dom.xd, sitelocation.xd))

### EXAMPLE 2: Non-square matrices

# take two subsets of sites with different dominant grass abundances
# this produces a non-square matrix

dom1 <- subset(graze, POPR > 45 & DAGL < 20) # 13 sites
dom2 <- subset(graze, POPR < 45 & DAGL > 20) # 8 sites

# first two columns are site info
dom.xd <- xdistance(dom1[, -c(1,2)], dom2[, -c(1,2)], "bray")

# environmental and spatial distances; preserve rownames
forest.xd <- xdistance(dom1[, "forestpct", drop=FALSE],
  dom2[, "forestpct", drop=FALSE])
sitelocation.xd <- xdistance(dom1[, "sitelocation", drop=FALSE],
  dom2[, "sitelocation", drop=FALSE])
```

```
# permutes rows and columns of full nonsymmetric matrix
xmantel(dom.xd ~ forest.xd, dims=c(13, 8))
xmantel(dom.xd ~ forest.xd + sitelocation.xd, dims=c(13, 8))

plot(xmgram(dom.xd, sitelocation.xd))
```

z.no

Example for pmgram

Description

An object of class `mgram` for use in the example for `pmgram`. Many of the functions in `ecodist` take a long time to run, so prepared examples have been included.

Usage

```
data(z.no)
```

Format

See `pmgram` for current format specification.

Author(s)

Sarah Goslee

See Also

[pmgram](#), [z.z1](#),

Examples

```
#### Partial pmgram example

# generate a simple surface
# with complex nonlinear spatial pattern

x <- matrix(1:25, nrow=25, ncol=25, byrow=FALSE)
y <- matrix(1:25, nrow=25, ncol=25, byrow=TRUE)

# create z1 and z2 as functions of x, y
# and scale them to [0, 1]
z1 <- x + 3*y
z2 <- y - cos(x)

z1 <- (z1 - min(z1)) / (max(z1) - min(z1))
z2 <- (z2 - min(z2)) / (max(z2) - min(z2))

z12 <- (z1 + z2*2)/3
```

```

# look at patterns

layout(matrix(c(
  1, 1, 2, 2,
  1, 1, 2, 2,
  3, 3, 4, 4,
  3, 3, 5, 5), nrow=4, byrow=TRUE))

image(z1, col=gray(seq(0, 1, length=20)), zlim=c(0,1))
image(z2, col=gray(seq(0, 1, length=20)), zlim=c(0,1))
image(z12, col=gray(seq(0, 1, length=20)), zlim=c(0,1))

# analyze the pattern of z across space
z1 <- as.vector(z1)
z2 <- as.vector(z2)
z12 <- as.vector(z12)
z1.d <- dist(z1)
z2.d <- dist(z2)
z12.d <- dist(z12)

space <- cbind(as.vector(x), as.vector(y))
space.d <- dist(space)

# take partial correlogram without effects of z1
### pgram() is time-consuming, so this was generated
### in advance and saved.
### set.seed(1234)
### z.no <- pmgram(z12.d, space.d, nperm=1000, resid=FALSE)
### save(z.no, file="ecodist/data/z.no.rda")
plot(z.no)

# take partial correlogram of z12 given z1
### pgram() is time-consuming, so this was generated
### in advance and saved.
### set.seed(1234)
### z.z1 <- pmgram(z12.d, space.d, z2.d, nperm=1000, resid=FALSE)
### save(z.z1, file="ecodist/data/z.z1.rda")
plot(z.z1)

```

z.z1

Example for pmgram

Description

An object of class `mgram` for use in the example for `pmgram`. Many of the functions in `ecodist` take a long time to run, so prepared examples have been included.

Usage

```
data(z.z1)
```

Format

See [pmgram](#) for current format specification.

Author(s)

Sarah Goslee

See Also

[pmgram](#), [z.no](#),

Examples

```
#### Partial pmgram example

# generate a simple surface
# with complex nonlinear spatial pattern

x <- matrix(1:25, nrow=25, ncol=25, byrow=FALSE)
y <- matrix(1:25, nrow=25, ncol=25, byrow=TRUE)

# create z1 and z2 as functions of x, y
# and scale them to [0, 1]
z1 <- x + 3*y
z2 <- y - cos(x)

z1 <- (z1 - min(z1)) / (max(z1) - min(z1))
z2 <- (z2 - min(z2)) / (max(z2) - min(z2))

z12 <- (z1 + z2*2)/3

# look at patterns

layout(matrix(c(
  1, 1, 2, 2,
  1, 1, 2, 2,
  3, 3, 4, 4,
  3, 3, 5, 5), nrow=4, byrow=TRUE))

image(z1, col=gray(seq(0, 1, length=20)), zlim=c(0,1))
image(z2, col=gray(seq(0, 1, length=20)), zlim=c(0,1))
image(z12, col=gray(seq(0, 1, length=20)), zlim=c(0,1))

# analyze the pattern of z across space
z1 <- as.vector(z1)
z2 <- as.vector(z2)
z12 <- as.vector(z12)
z1.d <- dist(z1)
z2.d <- dist(z2)
z12.d <- dist(z12)

space <- cbind(as.vector(x), as.vector(y))
```

```
space.d <- dist(space)

# take partial correlogram without effects of z1
### pgram() is time-consuming, so this was generated
### in advance and saved.
### set.seed(1234)
### z.no <- pmgram(z12.d, space.d, nperm=1000, resids=FALSE)
### save(z.no, file="ecodist/data/z.no.rda")
plot(z.no)

# take partial correlogram of z12 given z1
### pgram() is time-consuming, so this was generated
### in advance and saved.
### set.seed(1234)
### z.z1 <- pmgram(z12.d, space.d, z2.d, nperm=1000, resids=FALSE)
### save(z.z1, file="ecodist/data/z.z1.rda")
plot(z.z1)
```

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