Package 'plant.ecol'

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Type Package

Title Quantitative Tools for Plant Ecology

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Depends R (>= 3.0), vegan, plotrix, mvtnorm

Suggests MASS, cluster

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Description Functions for plant community ecology.

License GPL (>= 2)

LazyLoad yes

NeedsCompilation no

R topics documented:

`alpha.div` *Functions for calculating alpha diversity.*

Description

The function `alpha.div` runs `Simp.index` or `SW.index` to calculate Simpson's, Inverse Simpson's or Shannon-Weiner diversities.

Alpha diversity quantifies richness and evenness within a sampling unit (replicate).

Simpson's index has a straightforward interpretation. It is the probability of reaching into a plot and simultaneously pulling out two different species. The inverse Simpson's diversity is equivalent to the probability that two randomly chosen individuals will be the same species. These measures have been attributed to Simpson (1949). While it does not allow straightforward interpretation of results, the Shannon-Weiner diversity (H') is another commonly used alpha-diversity measure based on the Kullback-Liebler information criterion (Macarthur and Macarthur 1961).

Usage

```
alpha.div(x,index)
Simp.index(x,inv)
SW.index(x)
```

Arguments

`x`	A vector or matrix of species abundances (e.g. counts). The functions assume that species are in columns and sites are in rows.
`index`	The type of alpha diversity to be computed. The function currently has three choices. `simp` = Simpson's diversity, `inv.simp`=inverse Simpson's, `shan` = Shannon-Weiner diversity.
`inv`	Logical, indicating whether or not Simpson's inverse diversity should be computed.

Value

A single diversity value is returned if `x` is a vector. A vector of diversities (one for each site) are returned if `x` is a matrix.

Author(s)

Ken Aho

References

Simpson, E. H. (1949) Measurement of diversity. *Nature*. 163: 688.

MacArthur, R. H., and MacArthur J. W. (1961) On bird species diversity. *Ecology*. 42: 594-598.

See Also

beta.div

Examples

```
data(varespec)
alpha.div(varespec,"simp")
```

---

beta.div *Beta diversity functions*

Description

Several methods for beta diversity calculation: Whittaker, average dissimilarity, i.e. $\bar{D}$, and half-change.

Usage

```
W.beta.div(x)
beta.dbar(x,index="steinhaus")
beta.dbar.halfchange(x,index="steinhaus")
beta.div(x,method=c("whittaker","dbar","half.change"),index="steinhaus")
```

Arguments

x	A community matrix with sites in rows and species in columns.
method	One of three possible choices in beta.div: "whittaker","dbar",or "half.change".
index	A dissimilarity or distance measure. Any measure from get.dist is acceptable.

Details

Beta diversity can unfortunately mean two related but different things. First, it can refer to the relationship between the total number of species in landscape, (i.e.gamma-diversity), and the richness in individual plots. As a result, this type of beta-diversity attempts to quantify community heterogeneity without consideration of spatial distance or an environmental gradient. Second, beta diversity can refer to a measure of the rate of change in species composition across a pre-defined spatial or environmental gradient (Velland 2001). The second, more complex type of measure is often called species turnover.

A simple formula for the first (non-gradient) type of beta-diversity is attributed to Whittaker (1960). It is:

$$\beta_W = \frac{\gamma}{\kappa} - 1,$$

where γ is the total number of species in the landscape, i.e gamma diversity, and κ is average plot richness. β_W attains it maximum value when no species are shared among plots. It reaches its minimum value, 0, when species composition is identical among plots. Multivariate resemblance measures are also conventionally used for measuring non-gradient beta diversity (e.g. Aho et al. 2008). The simplest approach is to find the mean dissimilarity in a distance matrix, $\bar{D}$. This approach addresses several of the problems implicit with Whittaker's function. Specifically, that Whittaker's method is 1) strongly affected by rare species and 2) considers only presence/absence, not abundance. A recommended adjustment to the distance matrix mean has been made by McCune and Grace (2002):

$$\beta_{HC} = \frac{ln(1 - \bar{D})}{ln(0.5)},$$

where $\bar{D}$ is the average dissimilarity. In this approach average distance is converted to a half change scale.

To measure the second type of beta-diversity (i.e. species turnover along a gradient) axes from Detrended Correspondence Analysis (DCA) have been used (Jongman et al. 1995). This approach is suitable because DCA utilizes Hill scaling to create its (indirect gradient) ordination axes. Complete turnover for a site in a species space occurs at a distance of about four axis units (four DCA standard deviations). DCA expands and contracts axes so that the rate of species turnover is more or less constant. Oksanen and Tonteri (1995) and others have contested this use of DCA axes and proposed more direct estimation of turnover along known (not indirect) ordination gradients.

Value

Returns beta diveristy.

Author(s)

Ken Aho

References

Aho, K., Roberts, D. W., and T. Weaver. (2008) Using geometric and non-geometric internal evaluators to compare eight vegetation classification methods. *Journal of Vegetation Science*. 19: 549-562.

Oksanen, J. and T. Tonteri. (1995) Rate of compositional turnover along gradients and total gradient length. *Journal of Vegetation Science* 6: 815-824.

Jongman, R. H. G., ter Braak, C. F. G., and O. F. R. van Tongern. (1995) *Data analysis In Community and landscape ecology*. Cambridge University Press. Cambridge, UK.

See Also

`get.dist`, `alpha.div`

Examples

```
data(varespec)
W.beta.div(varespec)
```

bromus — *Bromus tectorum dataset*

Description

Cheatgrass (*Bromus tectorum*) is an introduced annual graminoid that has invaded vast areas of sagebrush steppe in the intermountain west. Because it completes its vegetative growth stage relatively early in the summer, it leaves behind senescent biomass that burns easily. As a result areas with cheatgrass often experience a greater frequency of summer fires. A number of dominant shrub species in sagebrush steppe are poorly adapted to fire. As a result, frequent fires can change a community formerly dominated by shrubs to one dominated by cheatgrass. Nitrogen can also have a strong net positive effect on the cheatgrass biomass. A study was conducted at the Barton Road Long Term Experimental Research site (LTER) in Pocatello Idaho to simultaneously examine the effect of shrub removal and nitrogen addition on graminoid productivity.

Usage

```
data(bromus)
```

Format

The dataframe has 3 columns:

Plot Plot number.

Biomass Grass biomass in grams per meter squared.

Trt Treatment. C = Control, LN = Low nitrogen, HN = Hi Nitrogen, SR = Shrub removal.

cliff.env — *Environmental data for the community dataset cliff.sp*

Description

The data here are a subset of a dataset collected by Aho (2006) which describe the distribution of communities of lichens and vascular and avascular plant species on montane cliffs in Northeast Yellowstone National Park. Of particular interest was whether substrate (limestone or andesitic conglomerate) or water supply influenced community composition.

Usage

```
data(cliff.env)
```

Format

This data frame contains the following columns:

sub a factor with 2 levels `"Andesite"` and `"Lime"` describing substrate type.

water a factor with 3 levels `"W"` `"I"` `"D"` indicating wet, intermediate, or dry conditions.

Details

Two categorical environmental variables are described for 54 sites. `sub` describes the substrate; there are two levels: `"Andesite"` and `"Lime"`. `water` describes distance of samples from waterfalls which drain the cliff faces; there are three levels `"W"` indicating wet, `"I"` indicating intermediate, and `"D"` indicating dry.

Source

Aho, K.(2006) *Alpine ecology and subalpine cliff ecology in the Northern Rocky Mountains*. Doctoral dissertation, Montana State University, 458 pgs.

`cliff.sp` *Yellowstone NP cliff community data*

Description

A subset of a dataset collected by Aho (2006) which describes the distribution of communities of lichens and vascular and avascular plant species on montane cliffs in Northeast Yellowstone National Park. Of particular interest was whether substrate (limestone or andesitic conglomerate) or water supply influenced community composition.

Usage

```
data(cliff.sp)
```

Details

Responses are average counts from two 10 x 10 point frames at 54 sites. Abundance data are for eleven species, 9 lichens, 3 mosses, and 2 vascular plants. Data were gathered in the summer of 2004 on two andesitic/volcanic peaks (Barronette and Abiathar) with sedimentary layers at lower elevations.

Source

Aho, K.(2006) *Alpine ecology and subalpine cliff ecology in the Northern Rocky Mountains*. Doctoral dissertation, Montana State University, 458 pgs.

`climate` *A sample of world climate data*

Description

Climate metadata, temperature (in degrees celsius) and precipitation (in mm). Seperate files exist for average temperature, average low temperature, average high temperature, and absolute low temperature. Absolute low temperature was not available for Kuala Trengganu Malaysia, and its absolute minimimus are given as the average low temperatures.

Usage

```
data(precip)
```

Format

A data frame with 12 observations on the following 26 variables.

`Aberdeen.WA.USA` Weather station ABERDEEN 20 NNE, GRAYS HARBOR COUNTY is at about 47.26°N 123.70°W. Elevation about 132m above sea level. Temp data from 1961-1990, precip from 1927-1995 derived from NCDC TD 9641 Clim 81 1961-1990 Normals.

`Alice.Springs.Australia` Weather station ALICE SPRINGS AMO WAS 01 is at about 23.82°S 133.88°E. Elev about 546m about above sea level. Temp data from 1941-1992 derived from GHCN 2 Beta, Precip data from 1874-1990.

`Bangkok.Thailand` Weather station BANGKOK is at about 13.73°N 100.50°E. Elevation 2m above sea level Temp data from 1840-1990, Precip data from 1882-1989, derived from GHCN 1.

`Berkeley.CA.USA` Weather station BERKELEY is at about 37.86°N 122.26°W. Elevation 91m above sea level. Temp data from 1961-1990, Precip data from 1886-1989. Data derived from NCDC TD 9641 Clim 81.

`Caravelas.Brazil` Weather station CARAVELAS is at about 17.73°S 39.20°W. Elevation about 4m above sea level. Temp and Precip data from 1961-1990 derived from GHCN 1.

`Corvallis.OR.USA` Weather station CORVALLIS STATE UNIV, BENTON COUNTY is at about 44.63°N 123.20°W. Elevation about 68m above sea level. Temp data from 1961-1990, Precip from 1910-1995 derived from NCDC TD 9641 Clim 81 1961-1990 Normals.

`Dakhla.Egypt` Weather station DAKHLA is at about 25.48°N 29.00°E. Height about 106m above sea level Data from 1951-1988 derived from GHCN 1.

`Death.valley.CA.USA` Weather station DEATH VALLEY, INYO COUNTY is at about 36.46°N 116.86°W. Elevation about -59m with respect to sea level Temp data from 1961-1990, precip from 1961-1995 derived from NCDC TD 9641 Clim 81 1961-1990 Normals.

`Fairbanks.AK.USA` Weather station FAIRBANKS INTL AP, INTERIOR BSN is at about 64.81°N 147.86°W. Elevation about 132m above sea level. Temp data from 1961-1990, precip from 1949 and 1995 derived from NCDC TD 9641 Clim 81 1961-1990 Normals.

`Greenwich.UK` Weather station GREENWICH/MARITIME M is at about 51.50°N 0.00°E. Elevation about 7m above sea level data Temp data from 1841-1960, Precip from 1841-1960, Summaries from GHCN 1: The Global Historical Climatology Network, version 1.

`Hamburg.Germany` Weather station HAMBURG-FUHLSBUETTEL is at about 53.63°N 10.00°E. Elev about 16m above sea level. Temp and Precip data from 1951-1990 derived from GHCN 1.

`Jackson.WY.USA` Weather station JACKSON, TETON COUNTY is at about 43.48°N 110.76°W. Elevation about 1898m above sea level. Temp data from 1961-1990 derived from NCDC TD 9641 Clim 81 1961-1990 Normals. Precip data from 1931-1995

`Kuala.Trengganu.Malaysia` Weather station KUALA TRENGGANU is at about 5.38°N 103.10°E. Elevation about 6m above sea level. Temp data from 1961-1970, Precip data from 1930 and 1980 derived from GHCN 1.

`Lawrence.KA.USA` Weather station LAWRENCE, DOUGLAS COUNTY is at about 38.96°N 95.26°W. Elevation about 298m above sea level. Temp data from 1961-1990 derived from NCDC TD 9641 Clim 81 1961-1990 Normals.

`Lima.Peru` Weather station LIMA-CALLAO/AEROP. INTER is at about 12.00°S 77.09°W. Elevation about 13m above sea level. Temp data from 1910-1990, precip from 1950-1990 derived from GHCN 1.

`Manaus.Brazil` Weather station MANAUS is at about 3.13°S 60.00°W. Temp data from 1910-1988, Preicp from 1872-1989 derived from GHCN 1.

- `Mombasa.Kenya` Weather station MOMBASA is at about 4.03°S 39.60°E. Elevation about 57m above sea level. Temp data 1931-1990, Precip from 1890-1985 derived from GHCN 1.
- `Moscow.Russia` Weather station MOSKVA is at about 55.80°N 37.60°E. Elevation about 156m above sea level. Temp data from 1779-1991, Precip from 1820-1989. MOSKVA data derived from GHCN 2 Beta.
- `Muree.Pakistan` Weather station MURREE is at about 33.90°N 73.40°E. Elevation about 2169m above sea level. Temp data from 1936-1980, Precip from 1947-1971. Data derived from GHCN 2 Beta.
- `Osaka.JPN` Weather station OSAKA is at about 34.68°N 135.52°E. Elevation about 23m feet above sea level. Temp data from 1883-1990, Precip from 1883-1990. Data derived from GHCN 1.
- `Pocatello.ID.USA` Weather station POCATELLO MUNICIPAL, POWER COUNTY is at about 42.91°N 112.60°W. Elevation 1357m above sea level. Temp data from 1961-1990 derived from NCDC TD 9641 Clim 81 1961-1990 Normals. Precip data from 1917-1995.
- `Ponza.Italy` Weather station PONZA is at about 40.92°N 12.90°E. Elevabout about 184m above sea level. Temp and Precip data from 1961-1990. Summaries from GHCN 1.
- `San.Jose.Costa.Rica` Weather station SAN JOSE is at about 9.93°N 84.00°W. Elevation about 1172m above sea level. Temp data from 1961-1970, Preip from 1866-1982 derived from GHCN 1.
- `Sydney.Australia` Weather station SYDNEY is at about 33.86°S 151.19°E. Elevation 42m above sea level. Temp data from 1859-1990, precip from 1840-1989 derived from GHCN 1.
- `Tulear.Madagascar` Weather station TULEAR is at about 23.38°S 43.70°E. Elevation about 8m above sea level. Temp and Precip data from 1951-1990 derived from GHCN 1.
- `Turiacu.Brazil` Weather station TURIACU is at about 1.72°S 45.40°W. Data from 1911-1984 derived from GHCN 1.
- `Yellowknife.Canada` Weather station YELLOWKNIFE A,NW is at about 62.47°N 114.45°W. Elev about 205m above sea level. Temp and Precip data from 1942-1990 derived from GHCN 2 Beta.

Source

http://www.worldclimate.com/ http://www.myweather2.com/

`const` *Constancy of species in a community dataset*

Description

Calculates constancy of species in a community data (site x species matrix) with respect to categorical treatments (e.g. cluster analysis classes). Constancy of a species to a treatment is the proportion of times the species occurs at sites within the treatment.

Usage

```
const(Y, cat, digits = 4)
```

Arguments

`Y`	An n x p community site x species matrix.
`cat`	An n x 1 vector of categorical assignments.
`digits`	Number of significant digits in output.

Value

Output is a p x r matrix where r is the number of categorical levels in `cat`.

Author(s)

Ken Aho

See Also

`fidelity`, `veg.table`

Examples

```
data(dune)
data(dune.env)
const(dune,dune.env[,3])
```

`cover` *Mean abundance for categories*

Description

Calculate mean abundance measures with respect to a categorical variable.

Usage

```
cover(Y, cat)
```

Arguments

`Y`	An *n x p* community data matrix (generally sites in rows, species in columns).
`cat`	An *n x 1* vector of categories.

Author(s)

Ken Aho

See Also

`const`

Examples

```
data(dune)
data(dune.env)

cover(dune, dune.env$Management)
```

evaluators	*Cluster analysis evaluators.*

Description

A collection of classification evaluators. `McR.eval` provides both the McClain & Rao evaluator (W/B) (McClain and Rao 1975) and the PARTANA ratio (Roberts 2005); `Cindex.eval` = The *C*-index (Hubert and Levin 1976); `morisita.eval` = the Morisita index (adapted from Horn 1966); `biserial.eval` = point biserial correlation evaluator (Brogden 1949).

Usage

```
McR.eval(cat, dist, method = "McR")

Cindex.eval(cat, Y, index = "bray", stopif1 = FALSE)

morisita.eval(cat, Y)

biserial.eval(cat, dist)
```

Arguments

`cat`	Classification solution, a categorical vector.
`dist`	A dissimilarity or distance matrix, i.e. an object of `class="dist"`.
`method`	The method used in `McR.eval`. Options are `method="partana"` and `method="McR"`.
`Y`	A matrix of raw data, e.g. a community matrix.
`stopif1`	Logical argument specifying whether to *not* consider solutions with clusters consisting of one object.
`index`	Type of dissimilarity or distance metric to use. Any measure from `get.dist` is allowed

Details

More to come. Note that the function `McR.eval` is essentially the `partana` function from library `labdsv` with only a few minor adjustments.

Value

Returns an list of `class="eval"`. Printed will be the evaluator score for a classification solution; `invisible` objects will vary with method.

Note

The Morisita evaluator has been tested on a few datasets and appears to respond in a strongly linear fashion to the number of clusters.

Author(s)

David Roberts and Ken Aho

References

Brogden, H. E.(1949) A new coefficient: application to biserial correlation and to estimation of selective efficiency. *Psychometrika*. 14: 169-182.

Horn, H. S. (1966) Measurement of "overlap" in comparative ecological studies. *Am. Naturalist*. 100: 419-424.

Hubert, L. J. & Levin, J. R. (1976) A general framework for assessing categorical clustering in free recall. *Psychol. Bull*. 83: 1072-1080.

McClain, J. O. & Rao, V. R. (1975) CLUSTISZ: A program to test for the quality of clustering of a set of objects. *J. Marketing Res*. 12: 456-460.

Milligan, G. W. (1981) A Monte Carlo study of thirty internal criterion measures for cluster analysis. *Psychometrika*. 46(2): 187-199.

Milligan, G. W. & Cooper, M. C. (1985) An examination of procedures for determining the number of clusters in a dataset. *Psychometrika*. 50 (2): 159-179.

Milligan, G. W. & Isaac, P. D. (1980) The validation of four ultrametric clustering algorithms. *Pattern Recogn*. 12: 41-50.

Roberts, D. (2005) *Vegetation classification in R, for labdsv ver. 1.1-1, vegetation ecology package*. www.cran.r-project.org. unpubl.

See Also

get.dist

Examples

```
data(dune)
data(dune.env)

McR.eval(dune.env[,3],get.dist(dune,"bray"))
Cindex.eval(dune.env[,3],dune)
biserial.eval(dune.env[,3],get.dist(dune,"bray"))
```

---

evenness *Pielou's measure of species evenness*

Description

Calculates Pielou's measure of species evenness, i.e. $J = H'/\ln(S)$ where H' is Shannon Weiner diversity and S is the total number of species in a sample, across all samples in dataset.

Usage

```
evenness(x)
```

Arguments

x	A vector or matrix of species abundances (e.g. counts). The function assumes that species are in columns and sites are in rows.

Details

Many diversity indices incorporate evenness (e.g. Simpson's diversity, Shannon- Weiner diversity). Diversity indices which concentrate totally on evenness are fraught with problems including dependence on species counts (McCune and Grace 2002). A particular problem with Pielou's index is that it is a ratio of a relatively stable index, *H*', and one that is strongly dependent on sample size, *S*.

Value

Returns Pielou's *J*.

Author(s)

Ken Aho

References

McCune, B., and Grace, J.B. (2002) *Analysis of ecological communities*. MjM Software design. Gelenden Beach OR.

See Also

`SW.index`, `fidelity`, `const`

Examples

```
data(varespec)
evenness(varespec)
```

`fidelity` *Fidelity of species in a community to a particular group*

Description

The function `fidelity` calculates the proportion of experimental units (sites) in a group a species occurs in, compared to the total number of sites the species occurs in across all groups.

Usage

```
fidelity(Y, cat, digits = 4)
```

Arguments

`Y`	An n x p community matrix.
`cat`	An n x 1 vector of categorical assignments.
`digits`	The number of significant digits in output

Value

Returns a p x r matrix of species fidelities (where r is the number of categorical assignments, e.g. factor levels.)

Author(s)

Ken Aho

See Also

const, evenness, veg.table

Examples

```
data(dune)
data(dune.env)
fidelity(dune,dune.env[,3])
```

---

get.dist *Calculates 26 possible resemblance measures.*

Description

This function allows users access to 26 resemblance measures . This includes five not previously available in R. Many of the measures are programmed with the function designdist from library **vegan**. Minkowski's distance requires an additional specification for power. The default is power = 2 which makes the measure equivalent to Euclidean distance.

Usage

```
get.dist(data, method, minkowski.power = 2)
```

Arguments

data	A matrix for which resemblances between rows will be calculated
method	One of twenty six possible resemblance measures. These are: "matching", "rogers", "jaccard.pa", "sorenson", "kulkczynski.pa", "ochiai", "gower", "bray", "kulkczynski.q", "jaccard.q", "euclidean", "rel.euclidean", "manhattan", "czekanowski", "whittaker", "canberra", "chi.metric","chi.dist", "morisita", "morisita.horn", "minkowski", "mountford", "raup.crick", "binomial",or "chao".
minkowski.power	Minkowski's distance requires a specification for power. The default is `minkowski.power = 2` which makes the measure equivalent to Euclidean distance.

Value

Returns a matrix of `class(dist)`.

Author(s)

Ken Aho

References

Aho, K. In prep. *Applied statistics for biologists, a textbook using R*.

Legendre, P, and Legendre, L. (1998) *Numerical ecology, 2nd English edition*. Elsevier, Amsterdam, The Netherlands.

Oksanen, J., Kindt, R., Legendre, P., O'Hara, B., Simpson, G. L., and Stevens, M. H. H. (2008) *vegan: community ecology package. R package version 1.13-0*. https://CRAN.R-project.org/package=vegan

See Also

dist

Examples

```
data(varespec)
get.dist(varespec,method="bray")
```

Hotelling *Hotelling T-squared test*

Description

The Hotelling T-squared test provides a multivariate analog for a univariate test of two populations.

Usage

```
Hotelling(Y, X)
```

Arguments

Y	An n x p matrix of quantitative Y variables.
X	A n x 1 vector describing a factor with two factor levels.

Details

Details are provided in any introductory text on multivariate statistics. The same result will be given if a one way MANOVA is run on the data.

Value

Returns a list

D.sq	The Mahalanobis distance between the factor levels based on a pooled covariance matrix.
T.sq	The T^2 test statistic
table	A table with the F-statistic summary including the test statistic, numerator and denominator degrees of freedom, and the p-value

Author(s)

Ken Aho

References

Everitt, B. (2005) *An R and S-plus companion to multivariate analysis*. Springer.

See Also

manova

Examples

```
Y1<-rnorm(100,15,3)
Y2<-rnorm(100,17,2)
X<-factor(c(rep(1,50),rep(2,50)))

Hotelling(cbind(Y1,Y2),X)
anova(lm(cbind(Y1,Y2)~X))
```

Kullback — *Kullback test for equal covariance matrices.*

Description

Provides Kullback's (1959) test for multivariate homoscedasticity.

Usage

```
Kullback(Y, X)
```

Arguments

Y	An n x p matrix of quantitative variables
X	An n x 1 vector of categorical assignments (e.g. factor levels)

Details

Multivariate general linear models assume equal covariance matrices for all factor levels or factor level combinations. Legendre and Legendre (1998) recommend this test for verifying homoscedsticiy. *P*-values evaluate a null hypothesis of equal population covariance matrices.

Value

Returns a dataframe with the test statistic (which follows a chi-square distribution if H_0 is true), the chi-square degrees of freedom, and the calculated *p*-value.

Author(s)

Ken Aho

References

Kullback, S. (1959) *Information theory and statistics*. John Wiley and Sons.

Legendre, P, and Legendre, L. (1998) *Numerical ecology, 2nd English edition*. Elsevier, Amsterdam, The Netherlands.

See Also

V.mat

Examples

```
Y1<-rnorm(100,10,2)
Y2<-rnorm(100,15,2)
Y<-cbind(Y1,Y2)
X<-factor(c(rep(1,50),rep(2,50)))
Kullback(Y,X)
```

---

plantTraits *Plant traits for 136 species*

Description

This dataset, from the library `cluster`, describes 136 plant species according to biological attributes (morphological or reproductive).

Usage

```
data(plantTraits)
```

Format

A data frame with 136 observations on the following 31 variables.

pdias Diaspore mass (mg).

longindex Seed bank longevity.

durflow Flowering duration.

height Plant height, an ordered factor with levels '1' < '2' < ... < '8'.

begflow Time of first flowering, an ordered factor with levels '1' < '2' < '3' < '4' < '5' < '6' < '7' < '8' < '9'.

mycor Mycorrhizas, an ordered factor with levels '0'never < '1' sometimes< '2'always.

vegaer Aerial vegetative propagation, an ordered factor with levels '0'never < '1' present but limited< '2'important.

vegsout Underground vegetative propagation, an ordered factor with 3 levels identical to 'vegaer' above.

autopoll Selfing pollination, an ordered factor with levels '0'never < '1'rare < '2' often< the rule'3'.

insects Insect pollination, an ordered factor with 5 levels '0' < ... < '4'.

wind Wind pollination, an ordered factor with 5 levels '0' < ... < '4'.

lign A binary factor with levels '0:1', indicating if plant is woody.

piq A binary factor indicating if plant is thorny.

ros A binary factor indicating if plant is rosette.

semiros Semi-rosette plant, a binary factor ('0': no; '1': yes).

leafy Leafy plant, a binary factor.

suman Summer annual, a binary factor.

winan Winter annual, a binary factor.

monocarp Monocarpic perennial, a binary factor.

polycarp Polycarpic perennial, a binary factor.

seasaes Seasonal aestival leaves, a binary factor.

seashiv Seasonal hibernal leaves, a binary factor.

seasver Seasonal vernal leaves, a binary factor.

everalw Leaves always evergreen, a binary factor.

everparti Leaves partially evergreen, a binary factor.

elaio Fruits with an elaiosome (dispersed by ants), a binary factor.

endozoo Endozoochorous fruits, a binary factor.

epizoo Epizoochorous fruits, a binary factor.

aquat Aquatic dispersal fruits, a binary factor.

windgl wind dispersed fruits, a binary factor.

unsp Unspecialized mechanism of seed dispersal, a binary factor.

Details

Most of factor attributes are not disjunctive. For example, a plant can be usually pollinated by insects but sometimes self-pollination can occur.

Note

The description here follows directly from that in `cluster`.

Source

Vallet, Jeanne (2005) *Structuration de communautes vegetales et analyse comparative de traits biologiques le long d'un gradient d'urbanisation*. Memoire de Master 2 'Ecologie-Biodiversite-Evolution'; Universite Paris Sud XI, 30p.+ annexes (in french).

Maechler, M., Rousseeuw, P., Struyf, A., Hubert, M. (2005). *Cluster Analysis Basics and Extensions*; unpublished.

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polar.ord *Polar ordinations*

Description

The function currently creates two or three dimensional Bray-Curtis (polar) ordinations.

Usage

```
polar.ord(data, index = "bray", endpoint = c("BC.original",
"PC_ORD.original", "var.reg"), get.resid.dist = FALSE)
```

Arguments

`data`	A multivariate dataset, e.g. a community site x species matrix.
`index`	The dissimilarity or distance measure to be used. Any method from `get.dist` can be used.
`endpoint`	Endpoint selection is accomplished using either the Bray-Curtis original `"BC.original"` method (i.e. using the sites which are furthest apart), the PC-ORD original method `"PC_ORD.original"` (the first endpoint has the highest sum of distances from other sites, the second endpoint has the highest distance from the first endpoint), or using the variance regression `"var.reg"` method as described by McCune and Grace (2002). Note that the variance regression method in PC-ORD does not appear to be doing what it is supposed to be doing. The variance regression method in `polar.ord` is in accordance with in McCune and Grace (2002).
`get.resid.dist`	Logical. Allows one to see the residual distance matrices.

Details

The Bray-Curtis method is a relatively easy to understand ordination procedure that is also known as polar ordination because it arranges points in reference to endpoints or poles. The method is strongly favored by ecologists from the University of Wisconsin (probably because this is the school John Curtis graduated from and taught at). Curtis developed this method with the Canadian ecologist James Bray in the early 50s.

While polar ordination seems to work reasonably well for recovering community patterns, it has recently been very difficult to publish papers using this technique for two reasons: 1) it has been judged "outmoded" compared to more recently developed matrix decomposition methods, i.e. DCA and CCA, and 2) the endpoint selection techniques for axes can be arbitrary (more on this later). Edward Beals (1984) wrote a scathing critique of ecologists who undersold polar ordination. Here is an excerpt:

"While ordination as an approach to data analysis gained acceptance in the 1960's, the Bray-Curtis method came under attack beginning with Austin and Orloci (1966), and it quickly fell into disfavor among ecologists as new methods of ordination were introduced and championed. Only ecologists trained at the University of Wisconsin persisted in using Bray-Curtis, not out of blind loyalty, but because it generally gave more ecologically interpretable results than did newer or more sophisticated methods"

Endpoint selection is the most crucial step in the polar ordination process, because all other points will be placed in relation to the endpoints. The original Bray-Curtis method used the two most dissimilar points as endpoints. Two other methods, `"PC_ORD.original"` and `"var.reg"` are also allowed by `polar.ord`.

Value

Output includes scores, the amount of variance explained by axes, and, if requested, the residual distance matrices.

Author(s)

Ken Aho

References

Beals, E. W. 1984. Bray-Curtis ordination: an effective strategy for analysis of multivariate ecological data. *Advances in Ecological Research*. 14: 1-55.

McCune, B., and J.B. Grace. 2002. *Analysis of ecological communities*. MjM Software design. Gelenden Beach OR.

McCune, B. and E. W. Beals. 1993. History of the development Bray-Curtis ordination. Pp. 67-72 in J. S. Fralish, R. P. McIntosh, and O. L. Loucks eds. *John Curtis: Fifty Years of Wisconsin Plant Ecology*. Wisconsin Academy of Science, Arts and Letters, Madison WI.

See Also

get.dist

Examples

```
demodat<-matrix(ncol=3,nrow=5,data=c(2,3,5,7,9,1,4,0,6,2,5,5,10,2,2),
byrow=FALSE)
po.orig <-polar.ord(demodat,endpoint="BC.original",get.resid.dist=FALSE)
```

---

rad.plot *Plots depicting radiation and heatload*

Description

Incident radiation and heatload are plotted as a function of slope, aspect, and latitude (degrees N), on a syntheitc aspect slope hill diagram (SASH diagram; Aho et al. 2011). The artificial hill is spherical and grows steeper at its center. Fitted values are based on a polynomial algorithm from McCune and Keough (2002).

Usage

```
rad.plot(lat)
heat.plot(lat)
```

Arguments

lat	Latitude in degrees N.

Author(s)

Ken Aho

References

Aho, K., Weaver, T., and S. Regle (2011) Identification and siting of native vegetation types on disturbed land: demonstration of statistical methods. *Journal of Applied Vegetation Science* 14 (2): 277-290.

McCune, B., and D. Keon (2002) Equations for potential annual direct radiation and heat load. *Journal of Vegetation Science* 13: 603-606.

See Also

radiation.heatl

`radiation.heatl` *Radiation-heatload algorithm*

Description

The function radiation.heatl calculates annual incident solar radiation (MJ cm^2 yr^-1) and heatload (a radiation index based on the idea that highest amounts of radiation occur on southwest facing slopes in the northern hemisphere).

Usage

```
radiation.heatl(slope, aspect, lat)
```

Arguments

`slope`	slope (measured in degrees)
`aspect`	aspect (measured in degrees)
`lat`	latitude (measured in degrees)

Details

The function requires three types of data: `slope` (measured in degrees), `aspect` (measured in degrees), and northern latitude = `lat` (measured in degree). The function is based on equations from a paper written by McCune and Keon (2002). Note that this function ignores climatic factors including cloudiness, and is therefore is probably best for relative comparisons of radiation and heatload within a region and not for absolute measurements.

Value

`radiation`	Annual incident radiation in (MJ cm^2 yr^-1)
`heatload`	A unitless measure of heatload, maximized on SW aspects.

Author(s)

Ken Aho

References

McCune, B., and D. Keon (2002) Equations for potential annual direct radiation and heat load. *Journal of Vegetation Science*, 13: 603-606.

Examples

```
slope<-20
asp<-25
lat<-46
radiation.heatl(slope,asp,lat)
```

rankindex.new — *Compares the efficacy of resemblance measures for a particular data scenario.*

Description

This function is a wrapper for `rankindex` from package **vegan**.

Usage

```
rankindex.new(grad, veg, indices = c("matching", "rogers", "jaccard.pa", "sorensen",
"kulkczynski.pa", "ochiai", "gower", "bray", "kulkczynski.q", "jaccard.q",
"euclidean", "rel.euclidean", "manhattan", "czekanowski", "whittaker", "canberra",
 "chi.metric","chi.dist", "hellinger", "morisita", "morisita.horn", "minkowski",
 "mountford", "raup.crick", "binomial", "chao"), stepacross = FALSE,
 method = "pearson", ...)
```

Arguments

`grad`	An *s* x *e* matrix of environmental variables, where *s* = the number of sites and *e* = the number of environmental variables.
`veg`	An *s* x *p* community matrix, where *s* = the number of sites and *p* = the number of species.
`indices`	Some subset from the character string: `c("matching", "rogers", "jaccard.pa", "sorenson", "kulkczynski.pa", "ochiai", "gower", "bray", "kulkczynski.q", "jaccard.q", "euclidean", "rel.euclidean", "manhattan", "czekanowski", "whittaker", "canberra", "chi.metric", "chi.dist", "morisita", "morisita.horn", "minkowski", "mountford", "raup.crick", "binomial")`.
`stepacross`	Logical, specifies whether a step across transformation should be applied to the resemblance matrix.
`method`	What method is used to calculate correlations between environmental and communtiy matrices. Must be one of `"pearson"`, `"kendall"`, or `"spearman"`.
`...`	Other parameters to `stepacross` from vegan.

Details

A number of ecologists have evaluated the performance of distance measures by comparing environmental distance (i.e. differences along gradients) to distance in ordination space (Beals, 1984; Faith et al., 1987; De'ath, 1999). If species distributions are well described by environmental variables, then a strong association should exist between distances in species space and differences in environmental space. Thus, poor correlations represent poor performance by the distance measure. Obviously this analysis becomes more meaningful as the number of important environmental variables increases in ones measure of environmental distance. The library `vegan` has a function called rankindex which ranks dissimilarity or distances used for finding community distances or dissimilarities by how well these indices agree with gradient differences. The gradient separation between each point is expressed as Euclidean distance for continuous variables and as Gower's metric for mixed data (i.e. when at least some environmental variables are categorical or ordinal). In the later case the library **cluster** is required. The association of community and environmental distance matrices is simply the correlation of the community and environmental distance ranks and can be measured with any of the conventional measures described in Ch. 11. The function `rankindex.new` is a wrapper for rankindex and uses Oksanen's method to compare the efficacy of 25 of the 26 indices generated by get.dist. Mahalanobis distance is left out, since it does not create a distance matrix *per se*, but a simultaneous comparison of each site to all other sites.

Value

The function returns a table of ranked Pearson's correlations (default) and a barplot.

Author(s)

Ken Aho

References

Oksanen, J., Kindt, R., Legendre, P., O'Hara, B., Simpson, G. L., and Stevens, M. H. H. (2008) *vegan: community ecology package. R package version 1.13-0*. https://CRAN.R-project.org/package=vegan

See Also

get.dist

Examples

```
## Not run:

data(varechem)
data(varespec)
rankindex.new(scale(varechem),varespec)
## End(Not run)
```

Shep.comp — *Shepard plot type comparisons for PCoA*

Description

Calculates raw R^2, Linear fit R^2 and non-metric R^2 for PCoA ordinations.

Usage

```
Shep.comp(dis, max.dim = 10)
```

Arguments

dis	A dissimilarity matrix. Any index from get.dist can be used.
max.dim	The maximum number of cmdscale dimensions for which correlations should be calculated.

Details

The function Shep.comp in asbio creates calculates three sorts correlations coefficients across all specified PCoA dimensionalities.

1) Pearson's correlations of observed distances (in the distance matrix) and fitted distances (in a PCoA ordination); i.e. "raw fits."

2) Pearson's correlations between the monotonic fitted line and the observed distances "linear fits".

3) A correlation based on stress and calculated as 1 - S^2 (Oksanen 2008), where:

$$S = \sqrt{\frac{\sum_{i \neq j} \hat{d}_{ij} - d_{ij}^2}{\sum_{i \neq j} {d_{ij}}^2,}}$$

where $\hat{d}_{ij}$ is the distance between rank order of distance between point *i* and *j* in the final configuration (i.e. the fitted monotonic stressplot line), and d_{ij} is the distance between point *i* and *j* in the original distance matrix.

The first type of correlation "raw fits" should probably not be used since the relationship between community dissimilarity and a configuration may be strong while being non-linear. The second correlation should be linear even if the relationship between observed dissimilarity and dissimilarities in the final configuration are non-linear, and is often referred to as the linear fit (Oksanen 2008). The final type of correlation has been called "non-metric" fit (Oksanen 2008).

Value

Returns a matrix with three columns containing R^2 for raw, linear, and non-metric R^2's.

Author(s)

Ken Aho

References

Oksanen, J. (2008) *Multivariate analysis of ecological communities in R: vegan tutorial*. https://www.scribd.com/document/278497493/Vegan-Tutor

See Also

get.dist, cmdscale

Examples

```
data(varespec)
d<-get.dist(varespec,"bray")
Shep.comp(d,max.dim=10)
```

SM.temp.moist — *Alpine soil temperature and moisture time series*

Description

Soil temperature and water availabilty from Mt. Washburn in Yellowstone National Park. Data were taken at depth of 5cm from a late snowmelt site at UTM 4960736.977 544792.225 zone 12 NAD 83, elevation 3070m.

Usage

```
data(SM.temp.moist)
```

Format

A data frame with 30 observations on the following 4 variables.

`year` A numeric vector describing year.

`julian.day` The julian date

`Temp_C` Temperature in degrees celsius.

`Moisture` Soil water availability sensor reading. A reading of 35 is approximately equal to -1.5 MPa.

Source

Aho, K. (2006) Alpine ecology and subalpine cliff ecology in the Northern Rocky Mountains. Doctoral dissertation, Montana State University, 458 pgs.

sortid — *Sorts releve table rows using a dot product approach.*

Description

Sorts species(rows) in a releve or summarized releve table assuming a relevant order of columns. A dot product approach described below is used.

Usage

```
sortid(Y, gradient = 1)
```

Arguments

`Y`	An site x species (n x p) community matrix.
`gradient`	A constant used to establish the dot product see discussion below.

Details

A large number of ecologists have used sorted tables to describe patterns of data across gradients (Braun-Blanquet 1964, Hill 1973) . Perhaps the most common method to order a data matrix is to: 1) arrange columns (sites) in an order representing positions along a gradient (e.g. dry to wet), then 2) sort the species according to their dominance within the arranged columns. Hand sorting tables becomes burdensome for large complex datasets, and a large degree of subjectivity will be introduced (i.e. where does one put multimodal, randomly, or uniformly distributed species?). As a result, a number of methods have been developed to automatically sort the order of rows (species) with respect to the gradient represented by the order of columns (e.g. Tichy 2002). One method is to use weighted averaging so that species abundances are weighted by responses of the environmental variable determining the order of columns (Ter Braak and Looman 1986). While this method often produces good results, it is hampered by the distribution shape of the gradient (Jongman 1995). To address this problem I propose using a dot product algorithm (Stewart 2003, pg. 807) to find the order of rows. Consider an n x s matrix **M**, where s = the number of species, n = the number of sites, and c is a constant.

1. Create a vector, **v**, of length n with uniformly spaced intervals from -c to +c. Thus, if$n$ = 5, and c = 1, then **v** = (-1.0, -0.5, 0.0, 0.5, 1.0).

2. Take the dot product of **v** and the vector of abundances of spp 1 from sites 1 through n.

3. Create the vector, **d**, by calculating its elements $d_1, d_2, ..., d_s$, using step 2 above.

4. Sort the rows in **M** with the respect to descending values of **d**.

Note that **v** need not be uniformly distributed (see step 1 in the algorithm description above). To account for distribution shape in the gradient, any distribution (e.g. normal, lognormal) may be used.

Value

A sorted table, and the order of sorted rows (with respect to the original order), is returned.

Author(s)

Ken Aho

References

Braun-Blanquet, J. (1964) *Pflanzenoziologia. Grunduge der Vegetationskunde. 3*. Aufl. Berlin. Wien. Springer Verlag, New York, USA.

Hill, M. O. (1979) *TWINSPAN-A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes*. Ecology and Systematics. Cornell University, Ithaca, NY, US.

Jongman, R. H. G., ter Braak, C. F. G., and O. F. R. van Tongern. (1995) *Data analysis In Community and landscape ecology*. Cambridge University Press. Cambridge, UK.

Stewart, J. (2003) *Calculus: early transcendentals*. Thompson Learning Inc.

ter Braak, C. J. F., and C. W. N. Looman. (1986) Weighted averaging, logistic regression and the Gaussian response model. *Vegetatio*. 65: 3-11.

Tichy, L. (2002) JUICE, software for vegetation classification. *Journal of Vegetation Science*. 13: 451-453.

See Also

`veg.table`

Examples

```
data(dune)
sortid(t(dune))

# Sorting a summarized releve from veg.table
data(dune.env)
order <- sortid(t(dune))$sort
veg.table(dune, dune.env$Management, row.order = order)
```

---

transM *Transition matrix analysis*

Description

Creates a plot showing expected numbers of individuals in specified age classes or life stages given survivorship probabilities from a transition matrix (cf. Caswell 2000).

Usage

```
transM(A, init, inter = 100, stage.names = c("All grps",1:(ncol(A))),
leg.room = 1.5, line.col = seq(1, (ncol(A) + 1)), lwd = c(3, rep(1,
        ncol(A))), lty = 1,...)
```

Arguments

`A`	Transition matrix containing survivorship probabilities and fecundities see Caswell (2000).
`init`	A numeric vector containing initial numbers in each age class of interest.
`inter`	Number of time intervals for which population numbers are to be calculated.
`stage.names`	A character vector giving life stage names.
`leg.room`	A Y-axis multiplier intended to create room for a legend.
`line.col`	A vector of colors or a single color for graph lines.
`lwd`	A vector of line width or a single line width for graph lines.
`lty`	A vector of line types or a single line type for graph lines.
`...`	Additional arguments for `plot`

Value

Returns a plot and proportions of the population in each age class for the number of time intervals in `inter`.

Author(s)

Ken Aho

References

Caswell, H. 2000. *Matrix population models: Construction, analysis and interpretation, 2nd Edition*. Sinauer Associates, Sunderland, Massachusetts.

Gurevitch, J., Scheiner, S. M., and G. A. Fox. 2006. The ecology of Plants. Sinauer.

Examples

```
#Endangered cactus data data from Gurevitch et al. (2006)
A<-matrix(nrow=3,ncol=3,data=c(.672,0,.561,0.018,0.849,0,0,0.138,0.969),
byrow=TRUE)
init<-c(10,2,1)
transM(A,init,inter=100,stage.names=c("All","Sm. Juv.","Lg. Juv.","Adults"),
xlab="Years from present",ylab="n")
#animated version
## Not run:
anm.transM(A,init,inter=100,stage.names=c("All","Sm. Juv.","Lg. Juv.","Adults"),
xlab="Years from present",ylab="n")

## End(Not run)
```

V.mat *Pooled covariance matrices for multivariate procedures.*

Description

Calculates a pooled covariance matrix ala Legendre and Legendre (1998). This is required for a number of multivariate procedures including the Kullback statistic for multivariate homoscedasticity, and Hotelling's test.

Usage

```
V.mat(Y, X)
```

Arguments

Y	An n x p matrix of quantitative dependent variables.
X	A n x 1 of categorical groups (e.g. factor levels).

Author(s)

Ken Aho

References

Legendre, P, and L. Legendre (1998) *Numerical ecology, 2nd English edition*. Elsevier, Amsterdam, The Netherlands.

See Also

Kullback, Hotelling

Examples

```
Y1<-rnorm(100,12,2)
Y2<-rnorm(100,14,2)
X<-c(rep(1,50),rep(2,50))
V.mat(cbind(Y1,Y2),X)
```

veg.table	*Summarized constancy/cover vegetation tables (not vegetables)*

Description

Calculates vegetation cover and constancy within groups (factor) for species at a defined minimum constancy,then converts constancy and cover to codes. Three different cover classes systems can be specified. A method developed by Aho (2006), Daubenmire cover classes, and Braun-Blanquet cover classes.

Usage

```
veg.table(Y, cat, min.const = 0.3, method = "aho", cover.only = FALSE, row.order = NULL)
```

Arguments

`Y`	A site x species (*n x p*) community matrix.
`cat`	An n x 1 vector of categorical assignments. Must be a factor.
`min.const`	A constancy cutoff. To help distill information data will be subset into two components species with >= `min.const` in at least one group, and < `min.const` across all groups. `min.const`=0.
`method`	The type of cover codes to use. The choices are possible `aho`, `daub`, and `braun`
`cover.only`	Logical. If only cover output is desired then stipulate `cover.only = TRUE`
`row.order`	Customized row order with respect to original order in `Y`

Details

The function assumes that responses in the community matrix are percent cover, i.e. responses are generally in the range 0 - 100 (although responses greater than 100 are allowed). For constancy: 0 percent = ".", 0-10 = +, 10-20 = 1, 20-30 = 2, 30-40 = 3, 40-50 = 4, 50-60 = 5, 60-70 = 6,70-80 = 7, 80-90 = 8, 90-100 = 9.

Three different cover class systems can be specified.

Aho, i.e. method = `aho` cover classes use the following codes: 0 percent = ".", 0-0.01 = +, 0.01-1 = A, 1-2 = B, 2-5 = C, 5-25 = D, >25 = E.

Daubenmire,i.e. `daub` cover classes are as follows: 0 percent = ".", 0-5 percent = 1, 5-25 = 2, 25-50 = 3, 50-75 = 4, 75-95 = 5, >95 = 6.

Braun-Blanquet, i.e. `braun` cover classes are as follows: 0 percent = ".", 0-0.1 = "r", 0.1-1 = "+", 1-5 = 1, 5-25 = 2, 25-50 = 3, 50-75 = 4, >75 = 5.

The argument `min.const` allows creation of two summary cover and constancy matrices. The first contains species which have >= `min.const` within at least one of the categories/clusters. The second contains cover and constancy summaries for all other species

Value

A list with two of three possible components is returned. The components will change depending what is specified in `cover.only`

`const.cover`	A matrix with constancy and cover ciphers containing species with >= 30 percent constancy in at least one group

const.cover_less.than.min.const
: A matrix with constancy and cover ciphers containing species which do not have >= 30 percent constancy in at least one group

cover
: A matrix with constancy and cover ciphers containing species with >= 30 percent constancy in at least one group

Author(s)

Ken Aho; Tad Weaver contributed many of the ideas for cover/constancy ciphers and code ranges.

References

Aho, K. (2006) *Alpine ecology and subalpine cliff ecology in the Northern Rocky Mountains*. Doctoral dissertation, Montana State University, 458 pgs.

Gurevitch, J., Scheiner, S. M., and Fox, G. A. (2006) *The ecology of Plants*. Sinauer.

See Also

const

Examples

```
data(dune)
data(dune.env)
veg.table(Y=dune,cat=dune.env[,3])
```

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