Package 'spatialsegregation'

July 2, 2014

Type Package

Title Segregation measures for multitype spatial point patterns

Version 2.40

Date 2014-03-09

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Suggests

Depends spatstat (>= 1.15-2)

Description Summaries for measuring segregation/mingling in multitype spatial point patterns with graph based neighbourhood description.
Included indices: Mingling, Shannon, Simpson (also the non-spatial)
Included functionals: Mingling, Shannon, Simpson, ISAR, MCI.
Included neighbourhoods: Geometric, k-nearest neighbours, Gabriel, Delaunay.

License GPL (>= 2.0)

NeedsCompilation yes

Repository CRAN

Date/Publication 2014-03-09 19:27:16

R topics documented:

`spatialsegregation-package`
Spatial Segregation Measures

Description

Collection of measures or summaries of spatial multitype exposure: segregation vs. mingling of different types of points in a plane.

Details

This is a collection of summaries for multitype spatial point patterns (see package spatstat for more).

The package is developed for an article Rajala\&Illian 2010, and provides summaries for detecting simple inter-type effects in the pattern.

See the help of the functions for further information.

Package provides an example dataset object called `exposurepps`, documented separately.

Also, the Dixon bivariate test based on contingency tables is available.

```
Functions
------------------
segregationFun   -  General calculation function, please use one of the following wrappers:
minglingF        -   Mingling index
shannonF         -   Spatial Shannon index
simpsonF         -   Spatial Simpson index
isarF            -   ISAR function

mingling.index   -   Shortcut for a single value
shannon.index    -   -''-
simpson.index    -   -''-
isar.index       -   -''-

dixon            -   Dixon's 2-type contingency table tests
```

Author(s)

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References

Graz: The behaviour of the species mingling index m_{sp} in relation to species dominance and dispersion. Eur. J. forest research. 123:87-92, 2004.

Lewandowski, Pommerening: Zur Beschreibung der Waldstruktur - Erwartete und beobachtete Arten-Durchmischung. Forstwiss Centralbl, 116:129-139, 1997.

Rajala, Illian: A family of spatial biodiversity measures based on graphs, Env. Ecol. Stat. 2012

Reardon, O'sullivan: Measures of spatial segregation. Sociological methodology, 34:121-162, 2004.

Shimatani, Kubota: Quantitative assesment of multispecies spatial pattern with high species diversity. Ecological Research, 19, 2004.

Wiegand, Gunatilleke, Gunatilleke, Huth: How individual species structure diversity in tropical forests. PNAS, nov 16, 2007.

Examples

```
data(exposurepps)
help(exposurepps)
```

`biomassF` *Individual Species Area Relationship*

Description

Compute the biomass around individuals points. WARNING: Still under development. Please contant me if you want to use this.

Usage

```
biomassF(X, r=NULL, target=NULL, v2=FALSE, ...)
```

Arguments

`X`	Multitype point pattern of class `ppp` (see package 'spatstat'). The biomass (e.g. size) is to be in an element $mass.
`r`	Vector of sizes for neighbourhoods, e.g. `geometric` graph with different ranges.
`target`	Default NULL. Calculate only for target type. If NULL compute mean over all types.
`v2`	Logical. Return the average biomass instead of just sum.
`...`	Further parameters for the function `segregationFun`.

Details

Computes the neighbourhood for each point and then sums up the biomass in that neighbourhood.

Value

Returns an fv-object, see spatstat for more information.

Author(s)

Tuomas Rajala University of Jyvaskyla, Finland tuomas.rajala@iki.fi

References

Rajala, Illian: A family of spatial biodiversity measures based on graphs, Env. Ecol. Stat. 2012

Dixon's 2-type contingency table tests

Dixon's 2-type contingency table tests

Description

Computes the tests of segregation using nearest neighbour contingency tables introduced by Philip Dixon in his paper "Testing spatial segregation using a nearest-neighbor contingency table", Ecology, 75, p.1940-1948 (1994). The tests are an improvement on the Pielou's test of segregation.

The test is defined only for two-type spatial pattern.

Usage

```
dixon(X, prepR=0)
```

Arguments

X	Bivariate i.e. 2-type point pattern (see package 'spatstat')
prepR	Computes first the geometric neighbours with this distance, and then finds the nearest neighbours.

Details

See the paper by Dixon for details.

Author(s)

Tuomas Rajala University of Jyvaskyla, Finland tuomas.rajala@iki.fi

References

Philip Dixon: "Testing spatial segregation using a nearest-neighbor contingency table", Ecology, 75, p.1940-1948 (1994).

exposurepps *Example datasets for package spatialsegregation*

Description

Example datasets with 9 different scattering+exposure combinations.

Usage

```
data(exposurepps)
```

Format

A list with nine elements of class ppp.

Details

A list of 9 point patterns with different degrees of intra-species clustering and inter-species mingling.

The patterns are synthetically produced using a combination of the functions of this package as an energy function of a Gibbs model.

Author(s)

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Examples

```
 data(exposurepps)
 par(mfrow=c(3,3), mar=c(2,2,2,2))
 for(i in 1:9)plot(exposurepps[[i]])

# upper row has strong inter-type mingling effect
# lower row has strong inter-type repulsion or segregation
# left column has strong intra-type clustering
# right column has strong intra-type repulsion.

 par(mfrow=c(3,3), mar=c(3,3,4,3))
 for(i in 1:9)plot(  isarF(exposurepps[[i]]), cbind(ISARmean,theo)~par)
```

helper functions *Functions for the aid of segregation measures*

Description

Small functions included in package spatialsegregation, used for manipulation of forest datasets which have dbh-values (pp with an element $dbh).

Usage

```
clean.up.data(pp, dbh = 10, atleast = 10)
freqs(pp)
minusID(pp, minusR, dbh, atleast=0)
shake(pp, a = 0.001)
```

Arguments

pp	Multitype point pattern (see package 'spatstat')
atleast	Include specii with abundance atleast atleast.
dbh	Include only those points with dbh atleast dbh.
minusR	Range from the border withing which to exluce points (used for correction of estimates).
a	Size of displacement: x+Unif(-a,a), y+Unif(-a,a).

Details

Small functions to manipulate multitype point patterns.

clean.up.data: Returns a subsample fullfilling the given constrains.

freqs: Returns the abundance vector.

minusID: Returns a 0-1-vector indicating inclusion in a simple minus-correction.

shake: Shakes the pattern, i.e. adds a random displacement shift to each point.

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isarF *Individual Species Area Relationship*

Description

Compute the Individual Species Area Relationship (ISAR) or Local Species Richness, for a given multitype point pattern.

Usage

```
isarF(X, r=NULL, target=NULL, v2=FALSE, v3=FALSE, v4=FALSE, ... )
isar.index(X, r=4, ntype="knn", ...)
```

Arguments

X	Multitype point pattern of class ppp (see package 'spatstat')
r	Vector of sizes for neighbourhoods, e.g. geometric graph with different ranges.
target	Default NULL. Calculate only for target type. If NULL computes for each type + mean over all types.
v2	Logical. Estimate species-to-neighbours-ratio instead of just total number of species.
v3	Logical. Instead of summing number 1 for each species present, sum the average X$mass of each species present.
v4	Logical. Estimate ISAR using empty space probabilities instead of direct counts (equals the normal version in all my tests)
ntype	Sets the n'hood type to knn by default in isar.index.
...	Further parameters for the function segregationFun.

Details

Extension of ISAR-function introduced in WGGH07. In effect calculates the expected amount of different types present in the neighbourhood of a point in the pattern.

The function isarF is the calculation function for different neighbourhoods. Uses function segregationFun.

The function isar.index is a shortcut to get a single value for the pattern. Uses 4-nn graph by default.

Value

Returns an fv-object, see spatstat for more information.

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References

Rajala, Illian: A family of spatial biodiversity measures based on graphs, Env. Ecol. Stat. 2012

Wiegand, Gunatilleke, Gunatilleke, Huth: How individual species structure diversity in tropical forests. PNAS, nov 16, 2007.

`mciF` *Mean Composite Information*

Description

Compute the Mean Composite Information for a given multitype point pattern. See Podani\&Czaran 1997.

Usage

```
mciF(X, r=NULL, target=NULL, ...)
```

Arguments

`X`	Multitype point pattern of class `ppp` (see package 'spatstat')
`r`	Vector of sizes for neighbourhoods, e.g. `geometric` graph with different ranges.
`target`	If given, look at the surroundings of this type only.
`...`	Further parameters for the function `segregationFun`.

Details

The function `mciF` is the main calculation function. Uses function `segregationFun`.

Value

Returns an `fv`-object, see `spatstat` for more information.

Author(s)

Tuomas Rajala University of Jyvaskyla, Finland tuomas.rajala@iki.fi

References

Podani, Czaran: Individual-centered analysis of mapped point patterns representing multi-species assemblages. J. Veg. Sci. 8: 259-270, 1997.

`minglingF` *Spatial Mingling Index*

Description

Compute the Mingling index for a given multitype point pattern.

Usage

```
minglingF(X, r=NULL, target=NULL, ratio=FALSE, ...)
mingling.index(X, r=4, ntype="knn", ...)
```

Arguments

`X`	Multitype point pattern of class `ppp` (see package 'spatstat')
`r`	Vector of sizes for neighbourhoods, e.g. `geometric` graph with different ranges.
`target`	Default NULL. Calculate only for target type. If NULL computes for each type + mean over all types.
`ratio`	Default FALSE. If TRUE, scale the typewise values `$M_t$` using formula `$(1-M_tau)/lambda_tau$` which equals 1 for Poisson CSR.
`ntype`	The original mingling index uses `knn` neighbourhood type.
`...`	Further parameters for the function `segregationFun`.

Details

Extension of Mingling index introduced by Lewandowski\&Pommerening 1997. Measures the proportion of alien points in the neighbourhood of a specific type typical point of the pattern.

If no specific type is given, the function takes mean over all types. A typewise value is more useful, so they are also included.

The function `minglingF` is the main calculation function. Uses function `segregationFun`.

The function `mingling.index` is a shortcut to get a single value for the pattern. Uses 4-nn graph by default, which is the original Mingling index used by Lewandowski\&Pommerening 1997 and Graz 2004.

Value

Returns an `fv`-object, see `spatstat` for more information.

Author(s)

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References

Graz: The behaviour of the species mingling index m_{sp} in relation to species dominance and dispersion. Eur. J. forest research. 123:87-92, 2004.

Lewandowski, Pommerening: Zur Beschreibung der Waldstruktur - Erwartete und beobachtete Arten-Durchmischung. Forstwiss Centralbl, 116:129-139, 1997.

Rajala, Illian: A family of spatial biodiversity measures based on graphs, Env. Ecol. Stat. 2012

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shannonF *Spatial Shannon Index*

Description

Compute the spatial and aspatial Shannon index for a given multitype point pattern.

Usage

```
shannonF(X, r=NULL, v2=FALSE, ...)
shannon.index(X, spatial=FALSE, ...)
```

Arguments

X	Multitype point pattern of class ppp (see package 'spatstat')
r	Vector of sizes for neighbourhoods, e.g. geometric graph with different ranges.
spatial	If FALSE, return the classical aspatial index value.
v2	If TRUE, use the real number of types in neighbourhoods as the log-base instead of total population type count.
...	Further parametes for the function segregationFun.

Details

The form of Shannon index is *H = 1 - E(o)/E(N)*, where *E(N)* is the global entropy and *E(o)* is the local entropy calculated as *E(o)= - sum pi_tau log(pi_tau)*, where the sum is over the different types present in the pattern, and *pi_tau* is the expected frequency of type *tau* points in a neighbourhood of a typical point of the pattern.

The function shannonF is the calculation function. Uses function segregationFun.

The function shannon.index is a shortcut to get the non-spatial Shannon index.

Value

Returns an fv-object, see spatstat for more information.

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References

Rajala, Illian: A family of spatial biodiversity measures based on graphs, Env. Ecol. Stat. 2012

Reardon, O'sullivan: Measures of spatial segregation. Sociological methodology, 34:121-162, 2004.

`simpsonF` *Spatial Simpson Index*

Description

Compute the spatial and aspatial Simpson index for a given multitype point pattern.

Usage

```
simpsonF(X, r=NULL, ...)
simpson.index(X, spatial=FALSE, ...)
```

Arguments

`X`	Multitype point pattern of class `ppp` (see package 'spatstat')
`r`	Vector of sizes for neighbourhoods, e.g. `geometric` graph with different ranges.
`spatial`	If FALSE, return the classical aspatial index value.
`...`	Further parametes for the function `segregationFun`.

Details

The form of Simpson index is *S = 1 - sum pi_tau*, where the sum is over the types of the pattern, and *pi_tau* is like in Shimatani\& Kubota 2004.

The function `simpsonF` is the main calculation function. Uses function `segregationFun`.

The function `simpson.index` is a shortcut to get a single value for the pattern. Uses 4-nn graph by default.

Value

Returns an `fv`-object, see `spatstat` for more information.

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References

Rajala, Illian: A family of spatial biodiversity measures based on graphs, Env. Ecol. Stat. 2012

Shimatani, Kubota: Quantitative assesment of multispecies spatial pattern with high species diversity. Ecological Research, 19, 2004.

spatialsegregation-segregationFun
Spatial Segregation Function

Description

Compute the spatial exposure (segregation vs. mingling) features from a given multitype point pattern. Usage of shortcuts `minglingF`, `isarF`, `shannonF` and `simpsonF` highly recommended.

Usage

```
segregationFun(X, fun="isar", r=NULL, ntype="geometric", funpars=NULL,
toroidal=FALSE, minusRange=TRUE,  included=NULL, dbg=FALSE,
doDists=FALSE, prepRange=0.0, prepGraph=NULL, prepGraphIsTarget=FALSE,
weightMatrix=NULL, translate=FALSE)
```

Arguments

`X`	Multitype point pattern of class `ppp` (see package 'spatstat')
`fun`	Default "isar". Takes "isar","mingling","shannon" and "simpson", see below.
`r`	Vector for the neighbourhood defining graph, e.g. "geometric" graph with different ranges. See below.
`ntype`	Default "geometric". Type of the neighbourhood graph. Accepts: "knn", "geometric", "delauney", "gabriel".
`funpars`	Default NULL. Parameter(s) for the measure. Mingling: c(i,j), where i= only for type i (0 for all), j=1 -> ratio version. ISAR: i, i=type (integer). Shannon: 0 or 1, see `v2` in `shannonF`. Simpson: none.
`toroidal`	Default FALSE. If TRUE, use a toroidal correction in distance calculation. Works at the moment only for rectangular windows and "geometric" or "knn" graph.
`minusRange`	If TRUE, adaptive minus-sampling is employed. Overrides `included`-vector. If given as a positive number, `included`-vector is created with points with distance atleast minusRange from the border.
`included`	boolean-vector of length |pp|. included[i]==TRUE => pp[i] included in calculations. Used for minus-sampling border correction.
`dbg`	Default FALSE. Print additional runtime texts.
`doDists`	Default TRUE. Precalculate distances for speed. Be aware of memory requirements, n*(n-1)!
`prepRange`	Default 0. If >0, shrink the search space for neighbourhoods by searching only points within distance R i.e. precalculates a geometric graph.
`prepGraph`	Precalculated graph for the point pattern. If given, The `prepRange`, `dodists` and `toroidal` are ignored and calculations are carried using the prepGraph as a starting point. Useful for huge datasets.

prepGraphIsTarget
: If TRUE, precalculated graph prepGraph is used to calculate a single function value directly, all other neighbourhood parameters are ignored.

weightMatrix
: See isarF for this.

translate
: Use translation correction (see e.g. documentation of spatstat::Kest for details). Used only in mingling index.

Details

This is the general function for computing the spatial exposure (segregation/mingling) features. Used by minglingF, shannonF, simpsonF and isarF, which should be preferred for better (and nicer) outcome.

Possible neighbourhood relations for the spatial version include geometric, k-nearest neighbours, Delauney, and Gabriel. Delauney and Gabriel are parameter free, so given r has no meaning. In geometric graph, r is a vector of distances (sizes of the surrounding 'disc') and for k-nn r is the vector of neighbourhood abundances for each point to consider in the calculation of the spatial exposure measures. The basic type of spatial summary uses range, or 'geometric' graph connections with varying neighbourhood parameter.

For geometric and knn, the calculations are done by shrinking the graph given by the largest value of r. If dealing with large datasets, it is advisable to give preprocessing range, prepRange. The algorithm first calculates a geometric graph with parameter prepRange, and uses this as basis for finding the needed neighbourhoods. Speeds up calculations. prepGraph, if given, works as the preprocessed geometric graph. But make sure prepRange is large enough (e.g. in geometric, prepRange>max(r)).

The doDists option speeds up calculations by precomputing the pairwise distances but takes n*(n-1) memory!

For border correction, use minusRange for reduced border correction (for rectangular windows only). If using geometric or knn neighbourhoods, the option toroidal for toroidal correction is also available. The vector included can be given for more specific minus-correction, only those points with TRUE (1) value are used in calculation. However, the neighbourhoods are calculated with all points.

Value

Returns an object of class fv, see spatstat for more details. Basically a list with the computed values and parameter values.

Author(s)

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