Package 'sapo'

May 9, 2026

Type Package

Title Spatial Association of Different Types of Polygon

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Description In ecology, spatial data is often represented using polygons. These polygons can represent a variety of spatial entities, such as ecological patches, animal home ranges, or gaps in the forest canopy. Researchers often need to determine if two spatial processes, represented by these polygons, are independent of each other. For instance, they might want to test if the home range of a particular animal species is influenced by the presence of a certain type of vegetation. To address this, Godoy et al. (2022) (<doi:10.1016/j.spasta.2022.100695>) developed conditional Monte Carlo tests. These tests are designed to assess spatial independence while taking into account the shape and size of the polygons.

License GPL (>= 3)

Encoding UTF-8

SystemRequirements GDAL (>= 2.0.1), GEOS (>= 3.4.0), PROJ (>= 4.8.0)

Imports sf, methods, stats

Depends R (>= 4.0)

URL https://github.com/lcgodoy/sapo/

BugReports https://github.com/lcgodoy/sapo/issues/

RoxygenNote 7.3.2

Language en-US

Suggests knitr, rmarkdown

VignetteBuilder knitr

NeedsCompilation no

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Contents

`calc_h` $h\_12(t)$ *from matrix*

Description

Computes the h_{12} (K or L) based on a distance matrix based on a method

Usage

```
calc_h(x, var_st = FALSE, dists = NULL)
```

Arguments

`x`	distance matrix
`var_st`	logical scalar indicating if the L function should be used instead
`dists`	vector of distances to compute $h_{12}(t)$.

Value

a numeric vector

cmc_psat *Polygons Spatial Association Test - Global Envelope*

Description

A Monte Carlo test to verify if two sets of polygons are associated based in a global envelope of the functions $K_{12}(d)$ and $L_{12}(d)$ using different test statistics.

Usage

```
cmc_psat(
  p1,
  p2,
  id_col = NULL,
  n_sim = 499L,
  alpha = 0.01,
  var_st = TRUE,
  ts = "SMAD",
  distances = NULL,
  hausdorff = TRUE,
  method = "rnd_poly"
)
```

Arguments

p1	a sf object containing one column specifying the objects id.
p2	a sf object containing one column specifying the objects id.
id_col	a character or integer indicating the column of p1 storing the unique identifier for the polygons/sample units.
n_sim	an integer corresponding to the number of Monte Carlo simulations for the test
alpha	a numeric indicating the confidence level.
var_st	use the variance stabilizing funciton?
ts	a character associated to a test statistic. Inputs acepted: c('IM', 'MAD', 'SIM', 'SMAD', 'IMDQ', 'MADDQ').
distances	a numeric vector indicating the distances to evaluate $H(d)$. If NULL then the range considered goes from 5% to 20% of the max distance that can be observed inside the study region.
hausdorff	a logical scalar indicating whether the Hausdorff distance should be used (default is TRUE).
method	(default = "rng_poly") a character indicating the method used to deal with broken polygons in the Toroidal Shift. Valid options are c("min", "max", "mean", "rnd_poly", "rnd_dist", "min_norm", "max_norm", "hybrid", "hyb_center", "hybrid_nc", "old_min").

Value

a `list` with values:

p_value a `numeric` scalar giving the p-value of the test

mc_sample a `numeric` vector giving the test statistic for each of the Monte Carlo simulations

mc_funct a `matrix` where each line correspond to the function (K or L) estimated for the Monte Carlo simulations

distances `numeric vector` containing the distances where mc_func were evaluated.

alpha a `numeric` scalar giving the significance level

rejects a `logical` scalar, TRUE if the null hypothesis is reject

Examples

```
library(sapo)
library(sf)
set.seed(2024)

 ## loading toy data
poly1 <- system.file("extdata", "poly1.rds", package = "sapo") |>
  readRDS()
poly2 <- system.file("extdata", "poly2.rds", package = "sapo") |>
  readRDS()

my_ht <- cmc_psat(poly1, poly2, n_sim = 199)
my_ht$p_value
```

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create_jump *Create jumps for random movements*

Description

Create jumps for random movements

Usage

```
create_jump(unique_bb)
```

Arguments

unique_bb	a bbox shared between both "Polygon Patterns"

Details

This is an internal function.

Value

a `sfc` object representing a random jump or shift.

Author(s)

Lucas Godoy

`fix_dist` *Fix distance matrix containing broken polygons*

Description

fix a polygons' distance matrix based on a given method. This function assumes the polygon that has been broken is represented by the rows of the distance matrix.

Usage

```
fix_dist(x, method = "rnd_poly")
```

Arguments

`x`	distance matrix
`method`	method used to fix. The options are "min", "max", "mean", "rnd_poly", "rnd_dist", "min_norm", "max_norm", "hybrid", "hyb_center", "hybrid_nc", "old_min"

Value

a distance matrix

`hfun` $h\_12(t)$ *from polygons*

Description

Computes the h_{12} (K or L) based on a distance matrix based on a method

Usage

```
h_func(
  p1,
  p2,
  hausdorff = TRUE,
  method = "rnd_poly",
  var_st = FALSE,
  dists = NULL
)

h_func.list(x, ...)
```

Arguments

p1	sf object
p2	sf object
hausdorff	logical parameter indicating whether the Hausdorff distance should be used
method	method to deal with broken polygons
var_st	logical scalar indicating if the L function should be used instead
dists	vector of distances to compute $h_{12}(t)$.
x	a list with two sf objects.
...	Parameters to be used with h_func when inputting a list.

Value

a numeric vector

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iadist *ID aware distance matrix*

Description

Distance between polygons accounting for toroidal shift.

Usage

```
iadist(p1, p2, hausdorff = TRUE, method = "rnd_poly")
```

Arguments

p1	a sf object containing one column specifying the objects id.
p2	a sf object containing one column specifying the objects id.
hausdorff	logical scalar indicating whether the Hausdorff distance should be used.
method	method for "fixing" the distance matrix.

Value

a distance matrix.

Author(s)

Lucas Godoy

im *Integram Measure*

Description

Integram Measure

Usage

```
im(x, h = 1)
```

Arguments

x	numeric matrix
h	numeric

Value

numeric vector

im_ac *Integram Measure with Assimetry Correction*

Description

Integram Measure with Assimetry Correction

Usage

```
im_ac(x, h = 1)
```

Arguments

x	numeric matrix
h	numeric

Value

numeric vector

mad *Maximum Absolute Deviation*

Description

Maximum Absolute Deviation

Usage

```
mad(x)
```

Arguments

x	numeric matrix

Value

numeric vector

mad_ac *Maximum Absolute Deviation with Assimetry Correction*

Description

Maximum Absolute Deviation with Assimetry Correction

Usage

```
mad_ac(x)
```

Arguments

x	numeric matrix

Value

numeric vector

mean_aux *auxiliary mean*

Description

aux function to calculate the mean of a vector when removing each of its elements one by one.

Usage

```
mean_aux(x)
```

Arguments

x	a numeric vector

Value

a numeric vector

Author(s)

Lucas Godoy

pre_ts *Pre-TS*

Description

Create rigid copies of a polygon. This function an auxilliary function for the Toroidal Shift method

Usage

```
pre_ts(poly, bb = NULL, id_col = NULL)
```

Arguments

poly	an object of class sf or sfc.
bb	(optional) a unique bounding box.
id_col	a character indicating the id column in poly.

Value

an sf with 8 additional rigid copies of poly.

Author(s)

Lucas Godoy

sapo *sapo: Spatial Association of Polygon Types*

Description

sapo: Spatial Association of Polygon Types

s_im *Studentized Integram Measure*

Description

Studentized Integram Measure

Usage

```
s_im(x, h = 1)
```

Arguments

x	numeric matrix
h	numeric

Value

numeric vector

s_mad *Studentized Maximum Absolute Deviation*

Description

Studentized Maximum Absolute Deviation

Usage

```
s_mad(x)
```

Arguments

x	numeric matrix

Value

numeric vector

toroidal_shift *Toroidal Shift*

Description

Toroidal Shift

Usage

```
toroidal_shift(x, y, shifted = FALSE, unique_bb = NULL)
```

Arguments

x	a sf or sfc object. Its geometry may contain POLYGONS and/or POINTS.
y	a sf or sfc object. Its geometry may contain POLYGONS and/or POINTS.
shifted	logical indicating whether x has been "shifted". This parameter is mainly for internal use and testing.
unique_bb	a bbox shared between both "Polygon Patterns"

Value

a list

Author(s)

Lucas Godoy

translate_by_pt *Translate an* sf *object by a "point"*

Description

Translate an sf object by a "point"

Usage

```
translate_by_pt(pt, poly)
```

Arguments

pt	sfc representing a shift.
poly	sfc of sf to be shifted

Value

a sf or sfc representing poly shifted by pt

Author(s)

Lucas Godoy

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