

Package ‘IDSA’

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Type Package

Title An Interactive Detector for Spatial Associations

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Description Method of interactive detector for spatial associations (IDSA) as described in Yongze Song (2021) <doi:10.1080/13658816.2021.1882680>. IDSA is used to quantify the power of interactive determinant (PID) between a spatial response variable and explanatory variables. IDSA is developed based on methods of spatial heterogeneity.

Imports GD, stats, ggplot2, reshape2, utils, graphics, kableExtra

Depends R (>= 3.5.0)

License GPL-2

Encoding UTF-8

LazyData true

RoxygenNote 7.1.1

Suggests knitr, rmarkdown

VignetteBuilder knitr

NeedsCompilation no

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discretize	<i>Spatial discretization.</i>
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Description

Spatial discretization.

Usage

```
discretize(x, n, method)
```

Arguments

x	A numeric vector to be discretized
n	A number of breaks
method	A character of discretization method

Value

A vector of discretized variable of x.

Examples

```
x.disc <- discretize(x = runif(12), n = 3, method = "quantile")
table(x.disc)
```

fuzzyoverlay	<i>Spatial fuzzy overlay.</i>
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Description

Spatial fuzzy overlay.

Usage

```
fuzzyoverlay(y, layers, method = "fuzzyAND")
```

Arguments

y	A numeric vector of a response variable
layers	A data frame of spatial layers of explanatory variables.
method	A character of overlay methods, including "fuzzyAND" and "fuzzyOR"

Value

A data frame of a spatial fuzzy overlay variable.

Examples

```
library(GD)
data <- sim[, 4:6]
data.disc <- apply(data, 2, FUN = function(x) disc(x, 4, "quantile"))
layers <- do.call(cbind, lapply(1:ncol(data), function(x)
  data.frame(cut(data[, x], data.disc[[x]]$itv, include.lowest = TRUE))))
names(layers) <- names(data)
fo <- fuzzyoverlay(y = sim[,1], layers = layers, method = "fuzzyAND")
```

idsa	<i>IDSa model with spatial discretization parameters.</i>
------	---

Description

IDSa model with spatial discretization parameters.

Usage

```
idsa(formula, location, data, ndisc, methoddisc,
      methodoverlay = "fuzzyAND")
```

Arguments

formula	A formula of spatial variables
location	A character vector of location names in a data frame
data	A data frame of dataset
ndisc	A numeric vector of break numbers for respective explanatory variables
methoddisc	A character vector of discretization methods
methodoverlay	A character of spatial overlay methods, including "fuzzyAND" and "intersection"

Value

A list of IDSA results.

Examples

```
q.fand <- idsa(formula = y ~ xa + xb + xc, location = c("lo", "la"),
              data = sim, ndisc = c(4,6,6), methoddisc = "quantile",
              methodoverlay = "fuzzyAND")
q.ints <- idsa(formula = y ~ xa + xb + xc, location = c("lo", "la"),
              data = sim, ndisc = c(4,6,6), methoddisc = "quantile",
              methodoverlay = "intersection")
```

loessoptidisc	<i>Strategy 2: Optimal spatial data discretization for individual variables based on SPADE model.</i>
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Description

Strategy 2: Optimal spatial data discretization for individual variables based on SPADE model.

Usage

```
loessoptidisc(x, y)
```

Arguments

x	A numeric vector of break numbers
y	A numeric vector of q values

Value

A list of an optimal number of discretization and a plot.

Examples

```
lod <- loessoptidisc(x = 4:15, y = log(4:15 + runif(12)))
```

optidiscqs1	<i>Strategy 1: Optimal spatial data discretization for individual variables based on SPADE model.</i>
-------------	---

Description

Strategy 1: Optimal spatial data discretization for individual variables based on SPADE model.

Usage

```
optidiscqs1(y, x, location, ndisc, methoddisc)
```

Arguments

y	A numeric vector of a response variable
x	A numeric vector of a explanatory variable
location	A matrix of spatial locations
ndisc	A number of discretization
methoddisc	A character of discretization methods

Value

A list of an optimal spatial discretization using strategy 1.

Examples

```
od <- optidiscqs1(y = sim[, 1], x = sim[, 4:6], location = sim[, 2:3],
  ndisc = c(3:5), methoddisc = c("quantile", "equal"))
```

plotdisc	<i>Plot spatial discretization matrix.</i>
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Description

Plot spatial discretization matrix.

Usage

```
plotdisc(discmatrix, group)
```

Arguments

discmatrix	A matrix of spatial discretization
group	A vector of groups

Value

A data frame of spatial discretization matrix, which includes mean Q values in each group.

Examples

```
library(GD)
f1 <- formula(NDVIchange ~ Tempchange + Precipitation + Popdensity)
odc1 <- optidisc(f1, ndvi_40, discmethod = "quantile", discitv = c(3:20))
xvar <- all.vars(f1)[-1]
nx <- length(xvar)
dm <- do.call(data.frame, lapply(1:nx, function(u) odc1[[u]]$qv.matrix))
names(dm) <- xvar
pd <- plotdisc(discmatrix = dm, group = rep(1:6, each = 3))
```

 qs

Power of spatial determinant (PSD).

Description

Power of spatial determinant (PSD).

Usage

```
qs(y, xh, location)
```

Arguments

y	A numeric vector of a response variable
xh	A character variable, a data frame or a matrix of explanatory variables
location	A matrix of spatial locations

Value

A power of spatial determinant (PSD) value.

Examples

```
# an explanatory variable
library(GD)
data.disc <- disc(sim$xa, 4, "quantile")
xh <- cut(sim$xa, data.disc$itv, include.lowest = TRUE)
qs(sim$y, xh, location = sim[, c("lo", "la")])
# multiple explanatory variables
data <- sim[,4:6]
data.disc <- apply(data, 2, FUN = function(x) disc(x, 4, "quantile"))
xh <- do.call(cbind, lapply(1:ncol(data), function(x)
  data.frame(cut(data[, x], data.disc[[x]]$itv, include.lowest = TRUE))))
```

```
names(xh) <- names(data)
qs(sim$y, xh, location = sim[, c("lo", "la")])
```

qs1	<i>Power of spatial and multilevel discretization determinant (PSMD) of SPADE model for an individual explanatory variable.</i>
-----	---

Description

Power of spatial and multilevel discretization determinant (PSMD) of SPADE model for an individual explanatory variable.

Usage

```
qs1(y, x, xh, location)
```

Arguments

y	A numeric vector of a response variable
x	A numeric vector of a explanatory variable
xh	A character variable of an explanatory variable
location	A matrix of spatial locations

Value

A data frame of PSMD values.

Examples

```
library(GD)
data.disc <- disc(sim$xa, 4, "quantile")
xh <- cut(sim$xa, data.disc$itv, include.lowest = TRUE)
qs1(y = sim$y, x = sim$xa, xh = xh, location = sim[, c("lo", "la")])
```

qs2	<i>Power of interactive determinant for multiple explanatory variables in IDSA model.</i>
-----	---

Description

Power of interactive determinant for multiple explanatory variables in IDSA model.

Usage

```
qs2(y, x, xoverlay, location)
```

Arguments

y	A numeric vector of a response variable
x	A numeric vector of an explanatory variable
xoverlay	A character variable of an explanatory variable
location	A matrix of spatial locations

Value

A power of interactive determinant (PID) value from IDSA model.

Examples

```
library(GD)
data <- sim[,4:6]
data.disc <- apply(data, 2, FUN = function(x) disc(x, 4, "quantile"))
layers <- do.call(cbind, lapply(1:ncol(data), function(x)
  data.frame(cut(data[, x], data.disc[[x]]$itv, include.lowest = TRUE))))
names(layers) <- names(data)
fo <- fuzzyoverlay(y = sim[,1], layers = layers, method = "fuzzyAND")
q.idsa <- qs2(y = sim$y, x = data, xoverlay = fo$fuzzylayer,
  location = sim[, c("lo", "la")])
```

qs2all	<i>IDSA of all combinations</i>
--------	---------------------------------

Description

IDSA of all combinations

Usage

```
qs2all(y, x, xh, location, method = "fuzzyAND")
```


Arguments

y	A numeric vector of a response variable
x	A numeric vector of a explanatory variable
xh	A character variable of an explanatory variable
location	A matrix of spatial locations
method	A character of overlay methods

Value

A data frame of all possible power of interactive determinants (PID) values from IDSA models.

Examples

```
library(GD)
x <- sim[,4:6]
x.disc <- apply(x, 2, FUN = function(u) disc(u, 4, "quantile"))
xh <- do.call(cbind, lapply(1:ncol(x), function(u)
  data.frame(cut(x[, u], x.disc[[u]]$itv, include.lowest = TRUE))))
names(xh) <- names(x)
qidsa.all <- qs2all(y = sim$y, x = x, xh = xh,
  location = sim[, c("lo", "la")])
```

qsoverlay

PSD with an overlay variable.

Description

PSD with an overlay variable.

Usage

```
qsoverlay(x, xoverlay, location)
```

Arguments

x	A numeric vector of a explanatory variable
xoverlay	A character variable of an explanatory variable
location	A matrix of spatial locations

Value

A PSD value of an overlay variable.

Examples

```

library(GD)
data <- sim[, 4:6]
data.disc <- apply(data, 2, FUN = function(x) disc(x, 4, "quantile"))
layers <- do.call(cbind, lapply(1:ncol(data), function(x)
  data.frame(cut(data[, x], data.disc[[x]]$itv, include.lowest = TRUE))))
names(layers) <- names(data)
fo <- fuzzyoverlay(y = sim[,1], layers = layers, method = "fuzzyAND")
qo <- qsoverlay(x = data, xoverlay = fo$fuzzylayer,
  location = sim[, c("lo", "la")])

```

selectaddavar

Selecting and adding a variable to improve PID.

Description

Selecting and adding a variable to improve PID.

Usage

```

selectaddavar(y, x, xh, location, x.given, x.option,
  method = "fuzzyAND")

```

Arguments

y	A numeric vector of a response variable
x	A data frame or a matrix of explanatory variables
xh	A data frame or a matrix of discretized explanatory variables
location	A data frame of locations
x.given	A name of a start variable
x.option	A character vector of names of optional variables
method	A character of spatial overlay method

Value

A list of process data of improving PID values by adding a variable.

Examples

```

library(GD)
x <- sim[, 4:6]
x.disc <- apply(x, 2, FUN = function(u) disc(u, 4, "quantile"))
xh <- do.call(cbind, lapply(1:ncol(x), function(u)
  data.frame(cut(x[, u], x.disc[[u]]$itv, include.lowest = TRUE))))
names(xh) <- names(x)
sav <- selectaddavar(y = sim[, 1], x = x, xh = xh,

```

```
location = sim[, c("lo", "la")],
x.given = "xc", x.option = c("xa", "xb"),
method = "fuzzyAND")
```

selectgd

Selecting optimal interaction for GD model.

Description

Selecting optimal interaction for GD model.

Usage

```
selectgd(formula, data, ndisc, methoddisc)
```

Arguments

formula	A formula of spatial variables
data	A data frame of dataset
ndisc	A numeric vector of break numbers for respective explanatory variables
methoddisc	A character vector of discretization methods

Value

A list of process and results of optimal interaction for GD model.

Examples

```
s1 <- selectgd(formula = y ~ xa + xb + xc, data = sim,
               ndisc = c(4,6,6), methoddisc = "quantile")
```

selectidsa

Selecting optimal interaction for IDSA model.

Description

Selecting optimal interaction for IDSA model.

Usage

```
selectidsa(formula, data, location, ndisc, methoddisc)
```

Arguments

formula	A formula of spatial variables
data	A data frame of dataset
location	A character vector of location names in a data frame
ndisc	A numeric vector of break numbers for respective explanatory variables
methoddisc	A character vector of discretization methods

Value

A list of process and results of optimal interaction for IDSA model.

Examples

```
sim$xd <- log(sim$xa * sim$xb)
s1 <- selectidsa(formula = y ~ xa + xb + xc + xd, data = sim,
                 location = c("lo", "la"),
                 ndisc = c(4,6,6,5), methoddisc = "quantile")
```

sigratio

Ratio of significantly different zones.

Description

Ratio of significantly different zones.

Usage

```
sigratio(formula, data, ndisc, methoddisc, methodoverlay = "fuzzyAND")
```

Arguments

formula	A formula of spatial variables
data	A data frame of dataset
ndisc	A numeric vector of break numbers for respective explanatory variables
methoddisc	A character vector of discretization methods
methodoverlay	A character of spatial overlay methods, including "fuzzyAND" and "intersection"

Value

A list of ratios of significantly different zones.

Examples

```

sr1 <- sigratio(formula = y ~ xa + xb + xc, data = sim,
               ndisc = c(4,4,5), methoddisc = "quantile",
               methodoverlay = "fuzzyAND")
sr2 <- sigratio(formula = y ~ xa + xb + xc, data = sim,
               ndisc = c(4,4,5), methoddisc = "quantile",
               methodoverlay = "intersection")
sr1$n.zone; sr2$n.zone
sr1$ratio.sigdif; sr2$ratio.sigdif

```

sim	<i>Simulation data.</i>
-----	-------------------------

Description

Simulation data.

Usage

```
sim
```

Format

sim: A data frame with 713 rows and 7 variables

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spade	<i>SPADE model with spatial discretization parameters.</i>
-------	--

Description

SPADE model with spatial discretization parameters.

Usage

```
spade(formula, location, data, ndisc, methoddisc)
```

Arguments

formula	A formula of spatial variables
location	A character vector of location names in a data frame
data	A data frame of dataset
ndisc	A numeric vector of break numbers for respective explanatory variables
methoddisc	A character vector of discretization methods

Value

A data frame of power of determinants (PD) of individual variables from SPADE model.

Examples

```
q.spade <- spade(formula = y ~ xa + xb + xc, location = c("lo", "la"),
                 data = sim, ndisc = c(4,6,6), methoddisc = "quantile")
```

tau	<i>Spatial dependence parameter.</i>
-----	--------------------------------------

Description

Spatial dependence parameter.

Usage

```
tau(y, location)
```

Arguments

y	A numeric vector of a response variable
location	A matrix of spatial locations

Value

A value of spatial dependence parameter.

Examples

```
tau(y = sim[, 1], location = sim[, 2:3])
```

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