Package 'sdsfun'

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Title Spatial Data Science Complementary Features

Version 0.6.0

Description Wrapping and supplementing commonly used functions in the R ecosystem related to spatial data science,
while serving as a basis for other packages maintained by Wenbo Lv.

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BugReports https://github.com/stscl/sdsfun/issues

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tibble, utils

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Contents

`check_tbl_na` *check for NA values in a tibble*

Description

check for NA values in a tibble

Usage

```
check_tbl_na(tbl)
```

Arguments

`tbl`	A `tibble`

Value

A logical value.

Examples

```
demotbl = tibble::tibble(x = c(1,2,3,NA,1),
                         y = c(NA,NA,1:3),
                         z = 1:5)
demotbl
check_tbl_na(demotbl)
```

`discretize_vector` *discretization*

Description

discretization

Usage

```
discretize_vector(
  x,
  n,
  method = "natural",
  breakpoint = NULL,
  sampleprob = 0.15,
  seed = 123456789
)
```

Arguments

`x`	A continuous numeric vector.
`n`	(optional) The number of discretized classes.
`method`	(optional) The method of discretization, default is `natural`.
`breakpoint`	(optional) Break points for manually splitting data. When `method` is `manual`, `breakpoint` is required.
`sampleprob`	(optional) When the data size exceeds `3000`, perform sampling for discretization, applicable only to natural breaks. Default is `0.15`.
`seed`	(optional) Random seed number, default is `123456789`.

Value

A discretized integer vector

Examples

```
xvar = c(22361, 9573, 4836, 5309, 10384, 4359, 11016, 4414, 3327, 3408,
         17816, 6909, 6936, 7990, 3758, 3569, 21965, 3605, 2181, 1892,
         2459, 2934, 6399, 8578, 8537, 4840, 12132, 3734, 4372, 9073,
         7508, 5203)
discretize_vector(xvar, n = 5, method = 'natural')
```

---

dummy_tbl *transforming a category tibble into the corresponding dummy variable tibble*

Description

transforming a category tibble into the corresponding dummy variable tibble

Usage

```
dummy_tbl(tbl)
```

Arguments

tbl	A tibble or data.frame.

Value

A tibble

Examples

```
a = tibble::tibble(x = 1:3,y = 4:6)
dummy_tbl(a)
```

---

dummy_vec *transforming a categorical variable into dummy variables*

Description

transforming a categorical variable into dummy variables

Usage

```
dummy_vec(x)
```

Arguments

x	An integer vector or can be converted into an integer vector.

Value

A matrix.

Examples

```
dummy_vec(c(1,1,3,2,4,6))
```

---

formula_varname *get variable names in a formula and data*

Description

get variable names in a formula and data

Usage

```
formula_varname(formula, data)
```

Arguments

formula	A formula.
data	A data.frame, tibble or sf object of observation data.

Value

A list.

yname	Independent variable name
xname	Dependent variable names

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
formula_varname(PS_Score ~ EL_Score + OH_Score, gzma)
formula_varname(PS_Score ~ ., gzma)
```

`fuzzyoverlay` *spatial fuzzy overlay*

Description

spatial fuzzy overlay

Usage

```
fuzzyoverlay(formula, data, method = "and")
```

Arguments

`formula`	A formula of spatial fuzzy overlay.
`data`	A data.frame or tibble of discretized data.
`method`	(optional) Overlay methods. When `method` is `and`, use `min` to do fuzzy overlay; and when `method` is `or`,use `max` to do fuzzy overlay. Default is `and`.

Value

A numeric vector.

Note

Independent variables in the `data` provided to `fuzzyoverlay()` must be discretized variables, and dependent variable are continuous variable.

Examples

```
sim = tibble::tibble(y = stats::runif(7,0,10),
                     x1 = c(1,rep(2,3),rep(3,3)),
                     x2 = c(rep(1,2),rep(2,2),rep(3,3)))
fo1 = fuzzyoverlay(y~x1+x2,data = sim, method = 'and')
fo1
fo2 = fuzzyoverlay(y~x1+x2,data = sim, method = 'or')
fo2
```

generate_subsets *generate subsets of a set*

Description

generate subsets of a set

Usage

```
generate_subsets(set, empty = TRUE, self = TRUE)
```

Arguments

set	A vector.
empty	(optional) When empty is TRUE, the generated subset includes the empty set, otherwise the empty set is removed. Default is TRUE.
self	(optional) When self is TRUE, the resulting subset includes the set itself, otherwise the set itself is removed. Default is TRUE.

Value

A list.

Examples

```
generate_subsets(letters[1:3])
generate_subsets(letters[1:3],empty = FALSE)
generate_subsets(letters[1:3],self = FALSE)
generate_subsets(letters[1:3],empty = FALSE,self = FALSE)
```

geodetector_q *only geodetector q-value*

Description

only geodetector q-value

Usage

```
geodetector_q(y, hs)
```

Arguments

y	Dependent variable
hs	Independent variable

Value

A numeric value

Examples

```
geodetector_q(y = 1:7, hs = c('x',rep('y',3),rep('z',3)))
```

`hclustgeo_disc` *hierarchical clustering with spatial soft constraints*

Description

hierarchical clustering with spatial soft constraints

Usage

```
hclustgeo_disc(
  data,
  n,
  alpha = 0.5,
  D1 = NULL,
  hclustm = "ward.D2",
  scale = TRUE,
  wt = NULL,
  ...
)
```

Arguments

`data`	An `sf` object, `tibble`, `data.frame`, `matrix` or `vector` of observations data.
`n`	The number of hierarchical clustering classes, which can be a numeric value or vector.
`alpha`	(optional) A positive value between `0` and `1`. This mixing parameter gives the relative importance of "feature" space and "constraint" space. Default is `0.5`.
`D1`	(optional) A `matrix` with other dissimilarities between the same observations data. if `data` is an `sf` object and alpha is not `0`, the `D1` will be generated by `sdsfun::sf_distance_matrix()`, others will use a `matrix` with all elements equal to `0`.
`hclustm`	(optional) The agglomeration method to be used, default is `ward.D2`. For more details, please see `stats::hclust()`.
`scale`	(optional) Whether to scaled the dissimilarities matrix, default is `TRUE`.
`wt`	(optional) Vector with the weights of the observations. By default, `wt` is `NULL`.
`...`	(optional) Other arguments passed to `stats::dist()`.

Value

A vector with grouped memberships if n are scalar, otherwise a matrix with grouped memberships is returned where each column corresponds to the elements of n, respectively.

Note

This is a C++ enhanced implementation of the hclustgeo function in ClustGeo package.

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
gzma$group = hclustgeo_disc(gzma,5,alpha = 0.75)
plot(gzma["group"])
```

---

inverse_distance_swm *construct inverse distance weight*

Description

Function for constructing inverse distance weight.

Usage

```
inverse_distance_swm(sfj, power = 1, bandwidth = NULL)
```

Arguments

sfj	Vector object that can be converted to sf by sf::st_as_sf().
power	(optional) Default is 1. Set to 2 for gravity weights.
bandwidth	(optional) When the distance is bigger than bandwidth, the corresponding part of the weight matrix is set to 0. Default is NULL, which means not use the bandwidth.

Details

The inverse distance weight formula is $w_{ij} = 1/d_{ij}^{\alpha}$

Value

A inverse distance weight matrices with class of matrix.

Examples

```
library(sf)
pts = read_sf(system.file('extdata/pts.gpkg',package = 'sdsfun'))
wt = inverse_distance_swm(pts)
wt[1:5,1:5]
```

`loess_optnum` *determine optimal spatial data discretization for individual variables*

Description

Function for determining optimal spatial data discretization for individual variables based on locally estimated scatterplot smoothing (LOESS) model.

Usage

```
loess_optnum(qvec, discnumvec, increase_rate = 0.05)
```

Arguments

`qvec`	A numeric vector of q statistics.
`discnumvec`	A numeric vector of break numbers corresponding to `qvec`.
`increase_rate`	(optional) The critical increase rate of the number of discretization. Default is `0.05`.

Value

A two element numeric vector.

`discnum` optimal number of spatial data discretization

`increase_rate` the critical increase rate of the number of discretization

Note

When `increase_rate` is not satisfied by the calculation, the discrete number corresponding to the highest `q statistic` is selected as a return.

Note that `sdsfun` sorts `discnumvec` from smallest to largest and keeps `qvec` in one-to-one correspondence with `discnumvec`.

Examples

```
qv = c(0.26045642,0.64120405,0.43938704,0.95165535,0.46347836,
       0.25385338,0.78778726,0.95938330,0.83247885,0.09285196)
loess_optnum(qv,3:12)
```

`moran_test` *test global spatial autocorrelation*

Description

Spatial autocorrelation test based on global moran index.

Usage

```
moran_test(sfj, wt = NULL, alternative = "greater", symmetrize = FALSE)
```

Arguments

`sfj`	An `sf` object or can be converted to `sf` by `sf::st_as_sf()`.
`wt`	(optional) Spatial weight matrix. Must be a `matrix` class. If `wt` is not provided, `sdsfun` will use a first-order queen adjacency binary matrix.
`alternative`	(optional) Specification of alternative hypothesis as `greater` (default), `lower`, or `two.sided`.
`symmetrize`	(optional) Whether or not to symmetrize the asymmetrical spatial weight matrix **wt** by: 1/2 * (**wt** + **wt**'). Default is `FALSE`.

Value

A list with `moran_test` class and result stored on the `result` tibble. Which contains the following information for each variable:

`MoranI` observed value of the Moran coefficient

`EI` expected value of Moran's I

`VarI` variance of Moran's I (under normality)

`ZI` standardized Moran coefficient

`PI` *p*-value of the test statistic

Note

This is a `C++` implementation of the `MI.vec` function in `spfilteR` package, and embellishes the console output.

The return result of this function is actually a `list`, please access the result tibble using `$result`.

The non-numeric columns of the attribute columns in `sfj` are ignored.

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
moran_test(gzma)
```

normalize_vector *normalization*

Description

normalization

Usage

```
normalize_vector(x, to_left = 0, to_right = 1)
```

Arguments

x	A continuous numeric vector.
to_left	(optional) Specified minimum. Default is 0.
to_right	(optional) Specified maximum. Default is 1.

Value

A continuous vector which has normalized.

Examples

```
normalize_vector(c(-5,1,5,0.01,0.99))
```

rm_lineartrend *remove variable linear trend based on covariate*

Description

remove variable linear trend based on covariate

Usage

```
rm_lineartrend(formula, data, method = c("cpp", "r"))
```

Arguments

formula	A formula.
data	The observation data.
method	(optional) The method for using, which can be chosen as either cpp or r. Default is cpp.

Value

A numeric vector.

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
rm_lineartrend(PS_Score ~ ., gzma)
rm_lineartrend(PS_Score ~ ., gzma, method = "r")
```

---

sf_coordinates *extract locations*

Description

Extract locations of sf objects.

Usage

```
sf_coordinates(sfj)
```

Arguments

sfj	An sf object or can be converted to sf by sf::st_as_sf().

Value

A matrix.

Examples

```
pts = sf::read_sf(system.file('extdata/pts.gpkg',package = 'sdsfun'))
sf_coordinates(pts)
```

---

sf_distance_matrix *generates distance matrix*

Description

Generates distance matrix for sf object

Usage

```
sf_distance_matrix(sfj)
```

Arguments

sfj	An sf object or can be converted to sf by sf::st_as_sf().

Value

A matrix.

Examples

```
pts = sf::read_sf(system.file('extdata/pts.gpkg',package = 'sdsfun'))
pts_distm = sf_distance_matrix(pts)
pts_distm[1:5,1:5]
```

---

sf_geometry_name *sf object geometry column name*

Description

Get the geometry column name of an sf object

Usage

```
sf_geometry_name(sfj)
```

Arguments

sfj	An sf object.

Value

A character.

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
sf_geometry_name(gzma)
```

sf_geometry_type *sf object geometry type*

Description

Get the geometry type of an sf object

Usage

```
sf_geometry_type(sfj)
```

Arguments

sfj	An sf object.

Value

A lowercase character vector

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
sf_geometry_type(gzma)
```

sf_gk_proj_cgcs2000 *generates cgcs2000 Gauss-Kruger projection epsg coding character*

Description

Generates a Gauss-Kruger projection epsg coding character corresponding to an sfj object under the CGCS2000 spatial reference.

Usage

```
sf_gk_proj_cgcs2000(sfj, degree = 6L)
```

Arguments

sfj	An sf object or can be converted to sf by sf::st_as_sf().
degree	(optional) 3-degree or 6-degree zonal projection, default is 6L.

Value

A character.

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun')) |>
  sf::st_transform(4490)
sf_gk_proj_cgcs2000(gzma,3)
sf_gk_proj_cgcs2000(gzma,6)
```

`sf_utm_proj_wgs84` *generates wgs84 utm projection epsg coding character*

Description

Generates a utm projection epsg coding character corresponding to an `sfj` object under the WGS84 spatial reference.

Usage

```
sf_utm_proj_wgs84(sfj)
```

Arguments

`sfj`	An `sf` object or can be converted to `sf` by `sf::st_as_sf()`.

Value

A character.

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
sf_utm_proj_wgs84(gzma)
```

`sf_voronoi_diagram` *generates voronoi diagram*

Description

Generates Voronoi diagram (Thiessen polygons) for sf object

Usage

```
sf_voronoi_diagram(sfj)
```

Arguments

`sfj`	An `sf` object.

Value

An sf object of polygon geometry type or can be converted to this by sf::st_as_sf().

Note

Only sf objects of (multi-)point type are supported to generate voronoi diagram and the returned result includes only the geometry column.

Examples

```
pts = sf::read_sf(system.file('extdata/pts.gpkg',package = 'sdsfun'))
pts_v = sf_voronoi_diagram(pts)

library(ggplot2)
ggplot() +
  geom_sf(data = pts_v, color = 'red',
          fill = 'transparent') +
  geom_sf(data = pts, color = 'blue', size = 1.25) +
  theme_void()
```

---

spade_psd *only spade power of spatial determinant*

Description

only spade power of spatial determinant

Usage

```
spade_psd(y, hs, wt)
```

Arguments

y	Dependent variable
hs	Independent variable
wt	Spatial weight matrix

Value

A numeric value

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
wt1 = inverse_distance_swm(gzma)
spade_psd(y = gzma$PS_Score,
          hs = discretize_vector(gzma$PS_Score,5),
          wt = wt1)
```

spdep_contiguity_swm *constructs spatial weight matrices based on contiguity*

Description

Constructs spatial weight matrices based on contiguity via spdep package.

Usage

```
spdep_contiguity_swm(
  sfj,
  queen = TRUE,
  k = NULL,
  order = 1L,
  cumulate = TRUE,
  style = "W",
  zero.policy = TRUE
)
```

Arguments

sfj	An sf object or can be converted to sf by sf::st_as_sf().
queen	(optional) if TRUE, using queen contiguity, otherwise rook contiguity. Default is TRUE.
k	(optional) The number of nearest neighbours. Ignore this parameter when not using distance based neighbours to construct spatial weight matrices.
order	(optional) The order of the adjacency object. Default is 1.
cumulate	(optional) Whether to accumulate adjacency objects. Default is TRUE.
style	(optional) style can take values W, B, C, and S. More to see spdep::nb2mat(). Default is W.
zero.policy	(optional) if FALSE stop with error for any empty neighbour sets, if TRUE permit the weights list to be formed with zero-length weights vectors. Default is TRUE.

Value

A matrix

Note

When k is set to a positive value, using K-Nearest Neighbor Weights.

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
wt1 = spdep_contiguity_swm(gzma, k = 6, style = 'B')
wt2 = spdep_contiguity_swm(gzma, queen = TRUE, style = 'B')
wt3 = spdep_contiguity_swm(gzma, queen = FALSE, order = 2, style = 'B')
```

---

spdep_distance_swm *constructs spatial weight matrices based on distance*

Description

Constructs spatial weight matrices based on distance via spdep package.

Usage

```
spdep_distance_swm(
  sfj,
  kernel = NULL,
  k = NULL,
  bandwidth = NULL,
  power = 1,
  style = "W",
  zero.policy = TRUE
)
```

Arguments

sfj	An sf object or can be converted to sf by sf::st_as_sf().
kernel	(optional) The kernel function, can be one of uniform, triangular,quadratic(epanechnikov),quartic and gaussian. Default is NULL.
k	(optional) The number of nearest neighbours. Default is NULL. Only useful when kernel is provided.
bandwidth	(optional) The bandwidth, default is NULL. When the spatial reference of sf object is the geographical coordinate system, the unit of bandwidth is km. The unit used in the projection coordinate system are consistent with those used in the sf object coordinate system.
power	(optional) Default is 1. Useful when kernel is not provided.
style	(optional) style can take values W, B, C, and S. More to see spdep::nb2mat(). Default is W. For spatial weights based on distance functions, a style of B means using the original value of the calculated distance function.
zero.policy	(optional) if FALSE stop with error for any empty neighbour sets, if TRUE permit the weights list to be formed with zero-length weights vectors. Default is TRUE.

Details

five different kernel weight functions:

- uniform: $K_{(z)} = 1/2$,for $|z| < 1$
- triangular $K_{(z)} = 1 - |z|$,for $|z| < 1$
- quadratic (epanechnikov) $K_{(z)} = \frac{3}{4}\left(1 - z^2\right)$,for $|z| < 1$
- quartic $K_{(z)} = \frac{15}{16}\left(1 - z^2\right)^2$,for $|z| < 1$
- gaussian $K_{(z)} = \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}}$

For the equation above, $z = d_{ij}/h_i$ where h_i is the bandwidth

Value

A matrix

Note

When `kernel` is setting, using distance weight based on kernel function, Otherwise the inverse distance weight will be used.

Examples

```
pts = sf::read_sf(system.file('extdata/pts.gpkg',package = 'sdsfun'))
wt1 = spdep_distance_swm(pts, style = 'B')
wt2 = spdep_distance_swm(pts, kernel = 'gaussian')
wt3 = spdep_distance_swm(pts, k = 3, kernel = 'gaussian')
wt4 = spdep_distance_swm(pts, k = 3, kernel = 'gaussian', bandwidth = 10000)
```

---

spdep_lmtest *spatial linear models selection*

Description

spatial linear models selection

Usage

```
spdep_lmtest(formula, data, listw = NULL)
```

Arguments

`formula`	A formula for linear regression model.
`data`	An `sf` object of observation data.
`listw`	(optional) A listw. See `spdep::mat2listw()` and `spdep::nb2listw()` for details.

Value

A list

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
spdep_lmtest(PS_Score ~ ., gzma)
```

---

spdep_nb *construct neighbours list*

Description

construct neighbours list

Usage

```
spdep_nb(sfj, queen = TRUE, k = NULL, order = 1L, cumulate = TRUE)
```

Arguments

sfj	An sf object or can be converted to sf by sf::st_as_sf().
queen	(optional) if TRUE, using queen contiguity, otherwise rook contiguity. Default is TRUE.
k	(optional) The number of nearest neighbours. Ignore this parameter when not using distance based neighbours.
order	(optional) The order of the adjacency object. Default is 1.
cumulate	(optional) Whether to accumulate adjacency objects. Default is TRUE.

Value

A neighbours list with class nb

Note

When k is set to a positive value, using K-Nearest Neighbor

Examples

```
pts = sf::read_sf(system.file('extdata/pts.gpkg',package = 'sdsfun'))
nb1 = spdep_nb(pts, k = 6)
nb2 = spdep_nb(pts, queen = TRUE)
nb3 = spdep_nb(pts, queen = FALSE, order = 2)
```

spdep_skater *spatial c(k)luster analysis by tree edge removal*

Description

SKATER forms clusters by spatially partitioning data that has similar values for features of interest.

Usage

```
spdep_skater(sfj, k = 6, nb = NULL, ini = 5, ...)
```

Arguments

sfj	An sf object of observation data. Please ensure that the attribute columns are included in the SKATER analysis.
k	(optional) The number of clusters. Default is 6.
nb	(optional) A neighbours list with class nb. If the input nb is NULL, it will be constructed automatically using spdep_nb().
ini	(optional) The initial node in the minimal spanning tree. Defaul is 5.
...	(optional) Other parameters passed to spdep::skater().

Value

A numeric vector of clusters.

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
gzma_c = spdep_skater(gzma,8)
gzma$group = gzma_c
plot(gzma["group"])
```

spvar *spatial variance*

Description

spatial variance

Usage

```
spvar(x, wt, method = c("cpp", "r"))
```

Arguments

x	A numerical vector .
wt	The spatial weight matrix.
method	(optional) The method for calculating spatial variance, which can be chosen as either cpp or r. Default is cpp.

Details

The spatial variance formula is $\Gamma = \frac{\sum_i \sum_{j \neq i} \omega_{ij} \frac{(y_i - y_j)^2}{2}}{\sum_i \sum_{j \neq i} \omega_{ij}}$

Value

A numerical value.

Examples

```
gzma = sf::read_sf(system.file('extdata/gzma.gpkg',package = 'sdsfun'))
wt1 = inverse_distance_swm(gzma)
spvar(gzma$PS_Score,wt1)
```

---

ssh_test *test explanatory power of spatial stratified heterogeneity*

Description

Spatial stratified heterogeneity test based on geographical detector q value.

Usage

```
ssh_test(y, hs)
```

Arguments

y	Variable Y, continuous numeric vector.
hs	Spatial stratification or classification of each explanatory variable. factor, character, integer or data.frame, tibble and sf object.

Value

A tibble

Note

This is a C++ implementation of the factor_detector function in gdverse package.

Examples

```
ssh_test(y = 1:7, hs = c('x',rep('y',3),rep('z',3)))
```

`standardize_vector` *standardization*

Description

To calculate the Z-score using variance normalization, the formula is as follows:
$Z = \frac{(x - mean(x))}{sd(x)}$

Usage

```
standardize_vector(x)
```

Arguments

`x`	A numeric vector

Value

A standardized numeric vector

Examples

```
standardize_vector(1:10)
```

`tbl_all2int` *convert discrete variables in a tibble to integers*

Description

convert discrete variables in a tibble to integers

Usage

```
tbl_all2int(tbl)
```

Arguments

`tbl`	A `tibble`,`data.frame` or `sf` object.

Value

A converted tibble,data.frame or sf object.

Examples

```
demotbl = tibble::tibble(x = c(1,2,3,3,1),
                         y = letters[1:5],
                         z = c(1L,1L,2L,2L,3L),
                         m = factor(letters[1:5],levels = letters[5:1]))
tbl_all2int(demotbl)
```

---

tbl_xyz2mat *convert xyz tbl to matrix*

Description

convert xyz tbl to matrix

Usage

```
tbl_xyz2mat(tbl, x = 1, y = 2, z = 3)
```

Arguments

tbl	A tibble,data.frame or sf object.
x	(optional) The x-axis coordinates column number, default is 1.
y	(optional) The y-axis coordinates column number, default is 2.
z	(optional) The z (attribute) coordinates column number, default is 3.

Value

A list.

z_attrs_matrix A matrix with attribute information.

x_coords_matrix A matrix with the x-axis coordinates.

y_coords_matrix A matrix with the y-axis coordinates.

Examples

```
set.seed(42)
lon = rep(1:3,each = 3)
lat = rep(1:3,times = 3)
zattr = rnorm(9, mean = 10, sd = 1)
demodf = data.frame(x = lon, y = lat, z = zattr)
demodf
tbl_xyz2mat(demodf)
```

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