Package 'StrucDiv'

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Type Package

Title Spatial Structural Diversity Quantification in Raster Data

Version 0.2.1

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Description Spatial structural diversity refers to the spatial, i.e. horizontal arrangement of landscape elements and can reveal itself as landscape features, such as patches and linear features. The 'R' package 'StrucDiv' provides methods to quantify spatial structural diversity in continuous remote sensing data, or in other data in raster format. Structure is based on the spatial arrangement of value pairs. The 'R' package 'StrucDiv' includes methods to combine information from different spatial scales, which allows to quantify multi-scale spatial structural diversity.

License GPL (>= 3)

URL https://github.com/leilsc/StrucDiv

BugReports https://github.com/leilsc/StrucDiv

Depends R (>= 3.5.0)

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LinkingTo Rcpp, RcppProgress

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`Diversity` *Spatial Structural Diversity Metrics*

Description

The functions `entropy` , `entropyNorm`, `contrast`, `dissimilarity` and `homogeneity` are the (spatial) structural diversity metrics used in the default configurations of `strucDiv` and `strucDivNest`. Structural diversity entropy is `entropy` with different `delta` parameters. Shannon entropy is employed, when `delta = 0`. Shannon entropy has a window-dependent maximum when `strucDiv` is used, which may be violated when `strucDivNest` is used, depending on the posterior probabilities of pixel value co-occurrences. Additionally, the value gradient is considered when `delta = 1` or `delta = 2`. The values of structural diversity entropy with `delta = 1` or `delta = 2` are not restricted and depend on the values of the input raster. the metric `entropyNorm` is Shannon entropy normalized over maximum entropy, which depends on the size of the moving window when no nesting is used. The metric `entropyNorm` ranges between 0 and 1, when `strucDiv` is used, but may be larger than 1 when `strucDivNest` is used, depending on the posterior probabilities of pixel value co-occurrences. The metrics `contrast` and `dissimilarity` consider the value gradient, their values are not restricted and depend on the values of the input raster. The metric `homogeneity` quantifies the closeness of empirical probabilities to the diagonal and ranges between 0 and 1 when `strucDiv` is used, but may be larger than 1 when `strucDivNest` is used, depending on the posterior probabilities of pixel value co-occurrences.

Usage

```
homogeneity(
  rank,
  delta,
```

```
  Hetx,
  vMat_big = NULL,
  SpatMat,
  nrp,
  narm,
  display_progress = TRUE,
  ...
)

dissimilarity(
  rank,
  delta,
  Hetx,
  vMat_big = NULL,
  SpatMat,
  nrp,
  narm,
  display_progress,
  ...
)

contrast(
  rank,
  delta,
  Hetx,
  vMat_big = NULL,
  SpatMat,
  nrp,
  narm,
  display_progress,
  ...
)

entropy(
  rank,
  delta,
  Hetx,
  vMat_big = NULL,
  SpatMat,
  nrp,
  narm,
  display_progress,
  ...
)

entropyNorm(
  rank,
  delta,
```

```
  Hetx,
  vMat_big = NULL,
  SpatMat,
  nrp,
  narm,
  display_progress,
  ...
)
```

Arguments

rank	logical. Should values be replaced with ranks in each co-occurrence matrix (GLCM)? Defaults to FALSE.
delta	numeric, takes 3 options: 0, 1, or 2. The delta parameter defines how the differences between pixel values within a pixel pair are weighted. If rank = TRUE, delta defines how the differences between ranks are weighted. The default value is 0 (no weight). Set delta = 1 for absolute weights, or delta = 2 for squared weights. The delta parameter can only be set when the metric entropy is used. The metric dissimilarity automatically employs delta = 1, and contrast employs delta = 2.
Hetx	the structural diversity matrix that is returned by an internal function to the strucDiv and strucDivNest functions. The structural diversity metric is calculated on every element of the GLCM, which generates the structural diversity matrix Hetx. The sum of this matrix is assigned to the center pixel of the moving window.
vMat_big	matrix. The matrix containing the pixel values of the outer scale. Defaults to NULL, in which case no prior information is used.
SpatMat	the GLCM that is returned by an internal function to the strucDiv and strucDivNest functions.
nrp	integer. The total number of pixel pairs. nrp is calculated internally by the functions strucDiv and strucDivNest and passed to the structural diversity metric functions.
narm	logical. Should NAs be removed? narm is automatically set to 0 if na.handling = na.pass, and to 1 if na.handling = na.omit.
display_progress	logical. Should a progress bar be displayed?
...	possible further arguments.

Details

These functions are used internally and are called as an argument to the strucDiv and strucDivNest functions.

DiversityDom *Spatial Structural Diversity Metrics*

Description

The functions entropyDom , entropyNormDom, contrastDom, dissimilarityDom and homogeneityDom are the spatial structural diversity metrics used in the default configurations of strucDivDom. For programming reasons, these metrics have different name endings than the metrics used in the functions strucDiv and strucDivNest, but they have the same mathematical formulation. Hence, entropyDom is specified by the same equation as entropy, and so forth. Structural diversity entropy is entropyDom with different delta parameters. Shannon entropy is employed, when delta = 0. The metric entropyDom has a scale-dependent maximum. Scale, here, refers to the extent of the domain. The metric entropyNormDom is Shannon entropy normalized over maximum entropy. The metric entropyNormDom ranges between 0 and 1. Additionally, the value gradient is considered with delta = 1 and delta = 2. The values of structural diversity entropy with delta = 1 or delta = 2 are not restricted and depend on the values of the input raster. The metric dissimilarityDom employs delta = 1, contrastDom employs delta = 2. The values of dissimilarityDom and contrastDom are not restricted and depend on the values of the input raster. The metric homogeneityDom quantifies the closeness of empirical probabilities to the diagonal and ranges between 0 and 1.

Usage

```
homogeneityDom(rank, delta, PMat, xVal, nrp)

dissimilarityDom(rank, delta, PMat, xVal, nrp)

contrastDom(rank, delta, PMat, xVal, nrp)

entropyDom(rank, delta, PMat, xVal, nrp)

entropyNormDom(rank, delta, PMat, xVal, nrp)
```

Arguments

rank	logical. Should values be replaced with ranks in the co-occurrence matrix (GLCM)? Defaults to FALSE.
delta	numeric, takes 3 options: 0, 1, or 2. The parameter delta is the difference weight parameter, it defines how the differences between pixel values within a pixel pair should be weighted. If rank = TRUE, delta defines how the differences between ranks should be weighted. The default value is 0 (no weight). Set delta = 1 for absolute weights, or delta = 2 for square weights. The delta parameter can only be set when the metric entropyDom is used. The metric dissimilarityDom automatically employs delta = 1, and contrastDom employs delta = 2.
PMat	the GLCM that is returned by an internal function to the strucDivDom function.
xVal	the unique values in the raster layer. calculated internally.
nrp	the normalizing constant calculated internally based on the raster dimensions.

Details

These functions are used internally and are called as an argument to the `strucDivDom`.

`getValuesWindow` *Retrieve pixel values of a defined area. The area is defined by the size of a window, which is centered on one pixel.*

Description

Modified R Code from raster package raster::getValuesFocal. Returns one row per pixel, which contains the values of the pixel neighborhood that is defined by the size of the window. The size of the window is defined by the window side length (wsl). The window is centered on one specific pixel.

Usage

```
getValuesWindow(x, wsl, padValue, aroundTheGlobe, ...)
```

Arguments

`x`	raster layer. The input raster layer.
`wsl`	integer. The window side length. The window is defined by `wsl` x `wsl`.
`padValue`	atomic. If a pixel is on the edge of an image, padding should be used? Can be NA or a value.
`aroundTheGlobe`	logical. Does the image go around the globe?
`...`	possible further arguments.

Value

Returns a matrix. The matrix contains the values of the defined window centered on the respective pixel.

`ndvi` *NDVI*

Description

NDVI

Usage

```
ndvi
```

Format

A matrix with 221 rows and 1092 columns. Mean Normalized Difference Vegetation Index (NDVI).

`Modified remote sensing product` MOD13A1v006

`Device` MODIS sensor

`Year` 2018

`Aggregation` Mean aggregation over the growing season 2018

`Location` Study region in North East Eurasia

`Data quality` Only pixels with sufficient quality flags were used.

`NA handling` NA gaps were filled with a local neighborhood average.

`Value range` NDVI values below zero were excluded. NDVI values range between 0 and 1.

`Data retrieval` Data was pre-processed and downloaded from Google Earth Engine.

For further details, see https://lpdaac.usgs.gov/products/mod13q1v006/ and https://earthengine.google.com/

`ndvi.15gl` *NDVI, 15 gray levels*

Description

NDVI, 15 gray levels

Usage

```
ndvi.15gl
```

Format

A matrix with 221 rows and 1092 columns. Mean Normalized Difference Vegetation Index (NDVI), with reduced number of gray levels (15).

`Modified remote sensing product` MOD13A2v006

`Device` MODIS sensor

`Year` 2018

`Aggregation` Mean aggregation over the growing season 2018

`Gray level reduction` Data was binned into 15 bins of equal size.

`Location` Study region in North East Eurasia

`Data quality` Only pixels with sufficient quality flags were used.

`NA handling` NA gaps were filled with a local neighborhood average.

`Value range` NDVI values below zero were excluded. NDVI values range between 0 and 1.

`Data retrieval` Data was pre-processed and downloaded from Google Earth Engine.

For further details, see https://lpdaac.usgs.gov/products/mod13q1v006/ and https://earthengine.google.com/

Examples

```
# This dataset is essentially constructed via:
nGrayLevels <- 15
require(raster)
ndvi <- raster(StrucDiv::ndvi)
ndvi15 <- cut(ndvi, breaks=seq(minValue(ndvi), maxValue(ndvi), len=nGrayLevels + 1),
              include.lowest=TRUE, right=FALSE)
```

`patch` *simulated patch data*

Description

simulated patch data

Usage

```
patch
```

Format

A matrix with 90 rows and 90 columns. Simulated patches.

`Simulated random patches` The background is random structure, depicting no spatial correlation, and structure is also random within patches.

`Value range` Data contains 20 gray levels.

`strucDiv` *Quantify Spatial Structural Diversity in an Arbitrary Raster Layer*

Description

This is a wrapper function that returns a 'spatial structural diversity map' as a raster layer. Spatial refers to horizontal, i.e. spatially explicit, and 'spatial structural diversity' will hereafter be used synonymous to 'structural diversity'. Pixels are considered as pairs in user-specified distances and angles. Angles include horizontal and vertical direction, and the diagonals at 45° and 135°. The direction-invariant version considers all angles. The frequencies of pixel pairs are normalized by the total number of pixel pairs, which returns the gray level co-occurrence matrix (GLCM). The GLCM contains the empirical probabilities that pixel values are arranged in the specified way (distance and angle). The total number of pixel pairs depends on the extent of the area within which pixel pairs are counted, i.e. on the spatial scale. The spatial scale is defined by the window side length (`wsl`) of a moving window. The values in a GLCM are the same values that occur in the area within which pixel pairs were counted, therefore they can differ between GLCMs. In each GLCM, pixel values can be replaced with ranks. Structural diversity metrics are calculated on every element of

the GLCM, their sum is assigned to the center pixel of the moving window and represents spatial structural diversity of the area captured by the moving window. The final map is called a '(spatial) structural diversity map' and is returned as a raster layer with the same dimensions as the input raster.

Usage

```
strucDiv(
  x,
  wsl,
  dist = 1,
  angle = "all",
  rank = FALSE,
  fun,
  delta = 0,
  na.handling = na.pass,
  padValue = NA,
  aroundTheGlobe = FALSE,
  filename = "",
  verbose = TRUE,
  ...
)
```

Arguments

x	raster layer. Input raster layer for which spatial structural diversity should be calculated.
wsl	uneven integer. The window side length, wsl x wsl defines the size of the moving window. The window must be smaller than the dimensions of the input raster. The moving window defines the spatial scale on which spatial structural diversity is quantified.
dist	integer. The distance between two pixels that should be considered as a pair, defaults to dist = 1 (direct neighbors).
angle	string. The angle on which pixels should be considered as pairs. Takes 5 options: "horizontal", "vertical", "diagonal45", "diagonal135", "all". The direction-invariant version is "all", which considers all of the 4 angles. Defaults to "all".
rank	logical. Should pixel values be replaced with ranks in each GLCM? Defaults to FALSE.
fun	function, the structural diversity metric. Takes one of the following: entropy, entropyNorm, contrast, dissimilarity, or homogeneity. Structural diversity entropy is entropy with different delta parameters. Shannon entropy is employed when delta = 0. Shannon entropy has a scale-dependent maximum. Additionally, the value gradient is considered when delta = 1 or delta = 2. The values of structural diversity entropy with delta = 1 or delta = 2 are not restricted and depend on the values of the input raster. The metric entropyNorm is Shannon entropy normalized over maximum entropy, which depends on the

size of the moving window. The metric entropyNorm ranges between 0 and 1. The metrics contrast and dissimilarity consider the value gradient, their values are not restricted and depend on the values of the input raster. The metric homogeneity quantifies the closeness of empirical probabilities to the diagonal and ranges between 0 and 1. The metric homogeneity is 1 when all pixel pairs are the same and approaches 0 as differences increase.

delta — numeric, takes three options: 0, 1, or 2. The delta parameter defines how the differences between pixel values within a pixel pair should be weighted. If rank = TRUE, delta defines how the differences between ranks should be weighted. The default value is 0 (no weight). Set delta = 1 for absolute weight, or delta = 2 for squared weight. The delta parameter can only be set when the metric entropy is used. The metric dissimilarity automatically employs delta = 1, and contrast employs delta = 2.

na.handling — na.omit or na.pass. If na.handling = na.omit, NAs are ignored, structural diversity metrics are calculated with less values. In this case the GLCM does not sum to 1. If na.handling = na.pass and if there is at least one missing value inside the moving window, an NA is assigned to the center pixel. Therefore, the diversity map will contain more NAs than the input raster. Defaults to na.pass.

padValue — numeric or NA. The value of the padded cells at the edges of the input raster. Defaults to NA.

aroundTheGlobe — logical. If the input raster goes around the whole globe, set aroundTheGlobe = TRUE, and the input raster will be 'glued together' from both sides to calculate structural diversity without edge effects. Defaults to FALSE.

filename — character. If the output raster should be written to a file, define file name (optional).

verbose — logical. If verbose = TRUE, a progress bar will be visible. Defaults to TRUE.

... — possible further arguments.

Details

The memory requirement of the function is determined by raster::canProcessInMemory(). If the raster file cannot be processed in memory, its size needs to be reduced before strucDiv can be used.

Value

The output is a (spatial) structural diversity map, returned as a raster layer with the same dimensions as the input raster. When na.handling = na.pass, then the output map will have an NA-edge of 0.5*(wsl-1), and it will contain more missing values than the input raster. The output represents spatial structural diversity quantified on a spatial scale defined by the size of the moving window.

Examples

```
## Not run:
# Construct a small raster file containing realizations of normal random variables:
a <- raster::raster(matrix(rnorm(648), 18, 36))
raster::plot(a)
```

```
# Calculate contrast:
contrast_a <- strucDiv(a, wsl = 3, fun = contrast)
raster::plot(contrast_a)

# Calculate dissimilarity:
b <- raster::raster(matrix(rnorm(100), 10, 10))
raster::plot(b)
dissim_b <- strucDiv(b, wsl = 5, angle = "horizontal", fun = dissimilarity)
raster::plot(dissim_b)

# Calculate structural diversity entropy with delta = 2 on NDVI data binned to 15 gray levels
ndvi.15gl <- raster::raster(ndvi.15gl)
sde_ndvi15 <- strucDiv(ndvi.15gl, wsl = 3, fun = entropy, delta = 2)
raster::plot(sde_ndvi15)

## End(Not run)
```

`strucDivDom` *Returns the structural diversity value, the gray level co-occurrence matrix (GLCM) and the structural diversity matrix of the domain.*

Description

The function `strucDivDom` returns the spatial, i.e. horizontal, structural diversity value for the domain (i.e. the input raster). 'Spatial structural diversity' will hereafter be used synonymous to 'structural diversity'. The function also returns the gray level co-occurrence matrix (GLCM) and the structural diversity matrix of the domain. Structural diversity is calculated on every element of the GLCM, which generates the structural diversity matrix.

Usage

```
strucDivDom(x, dist = 1, angle = "all", rank = FALSE, fun, delta = 0)
```

Arguments

`x`	raster layer. Input raster layer for which structural diversity should be calculated.
`dist`	integer. The distance between two pixels that should be considered as a pair, defaults to `dist = 1` (direct neighbors).
`angle`	string. The angle on which pixels should be considered as pairs. Takes 5 options: `"horizontal"`, `"vertical"`, `"diagonal45"`, `"diagonal135"`, `"all"`. The direction-invariant version is `"all"`, which considers all of the 4 angles. Defaults to `"all"`.
`rank`	logical. Should pixel values be replaced with ranks in each GLCM? Defaults to `FALSE`.
`fun`	function, the structural diversity metric. Takes one of the following: `entropyDom`, `entropyNormDom`, `contrastDom`, `dissimilarityDom`, or `homogeneityDom`. Structural diversity entropy is `entropyDom` with different `delta` parameters. Shannon

entropy is employed when `delta = 0`. Shannon entropy has a scale-dependent maximum. Scale-dependent means dependent on the extent of he area within which structural diversity is quantified, because this area defines he total number of pixel pairs. The metric `entropyNormDom` is Shannon entropy normalized over scale-dependent maximum entropy. Additionally, the value gradient is considered with `delta = 1` and `delta = 2`. The values of structural diversity entropy with `delta = 1` or `delta = 2` are not restricted and depend on the values of the input raster. The metrics `contrastDom` and `dissimilarityDom` consider the value gradient, their values are not restricted and depend on the values of the input raster. The metric `homogeneityDom` quantifies the closeness of empirical probabilities to the diagonal and ranges between 0 and 1.

`delta` numeric, takes three options: `0`, `1`, or `2`. The parameter `delta` is the difference weight, it defines how the differences between pixel values within a pixel pair should be weighted. If `rank = TRUE`, delta defines how the differences between ranks should be weighted. Defaults to `0` (no weight). Set `delta = 1` for absolute weights, or `delta = 2` for square weights. The `delta` parameter can only be set when the metric `entropy` is used. the metric `dissimilarity` automatically employs `delta = 1`, and `contrast` employs `delta = 2`.

Details

The memory requirement of the function is determined by `raster::canProcessInMemory()`. If the raster file cannot be processed in memory, its size needs to be reduced before `strucDivDom` can be used.

Value

The output is a list containing the structural diversity value of the domain, which can be accessed with $div. the list also contains the gray level co-occurrence matrix ($GLCM) and the structural diversity matrix ($divMat) of the domain.

Examples

```
## Not run:
# Calculate entropy on simulated random patch data
a <- raster::raster(matrix(rnorm(100), 10, 10))
sdivDom <- strucDivDom(a, angle = "vertical", fun = entropyDom)
# Structural diversity value of the domain
div <- sdivDom$div
# Gray level co-occurrence matrix
glcm <- sdivDom$GLCM
# Diversity matrix
divmat <- sdivDom$divMat

## End(Not run)
```

`strucDivNest` *Quantify Spatial Structural Diversity Across Scales in an Arbitrary Raster Layer*

Description

This is a wrapper function that returns a 'spatial structural diversity map' as a raster layer. Spatial refers to horizontal, i.e. spatially explicit, and 'spatial structural diversity' will hereafter be used synonymous to 'structural diversity'. Pixels are considered as pairs in user-specified distances and angles. Angles include horizontal and vertical direction, and the diagonals at 45° and 135°. The direction-invariant version considers all angles. Spatial structural diversity is quantified based on the probabilities that pixel values are arranged in the specified way (distance and angle). The `strucDiv` function employs empirical probabilities of pixel value co-occurrence. The `strucDivNest` function combines information from two different scales with an empirical Bayesian approach and a Beta-Binomial model. Two scales are nested inside each other - a larger, outer scale and a smaller, inner scale. Three different nesting schemes are available, whereby the inner scale is always a moving window. The outer scale can either be another mowing window, a block, or the domain (i.e. the input raster). The outer scale is used as prior information for data on the inner scale, and structural diversity is quantified based on posterior probabilities of pixel value co-occurrences. In the Beta-Binomial model both the prior and the posterior follow a beta distribution, and the likelihood follows a conditional binomial distribution. Posterior probabilities are estimated with mean estimates. The final map is called a '(spatial) structural diversity map' and is returned as a raster layer. The output map represents structural diversity, quantified across different spatial scales, which are defined by the outer scale and the inner scale.

Usage

```
strucDivNest(
  x,
  wslI = NULL,
  wslO = NULL,
  dimB = FALSE,
  oLap = NULL,
  priorB = FALSE,
  domain = FALSE,
  dist = 1,
  angle = "all",
  rank = FALSE,
  fun,
  delta = 0,
  na.handling = na.pass,
  padValue = NA,
  aroundTheGlobe = FALSE,
  ncores = 1,
  verbose = TRUE,
  filename = "",
  ...
```

)

Arguments

x	raster layer. Input raster layer for which horizontal structural diversity should be calculated.
wslI	uneven integer. The window side length of the inner scale, wslI x wslI defines the size of the inner moving window. The window must be smaller than the dimensions of the input raster and smaller than the outer scale. Default is NULL, in which case no prior information is used.
wslO	uneven integer. The window side length of the outer scale, wslO x wslO defines the size of the outer moving window. The window must be smaller than the dimensions of the input raster and larger than the inner scale (i.e. wslI). Defaults to NULL, in which case no prior information is used.
dimB	a vector of length 2 or logical. This defines the block size (number of rows, number of columns). The domain (i.e. the input raster) is divided into equal size, overlapping blocks. Each block provides prior information for the inner window, which moves inside each block. Structural diversity is quantified in each block. Blocks are merged together in a spatially weighted manner, using linear weights. Defaults to FALSE, in which case no blocks are used.
oLap	integer. This defines the size of overlap between the blocks. The overlap must be at least wslI-1 or bigger. Blocks can overlap by a maximum of half the rows of blocks in row-direction, and by half the columns of blocks in column-direction. If oLap is not specified, the minimum overlap is used. Defaults to NULL in which case no blocks are used.
priorB	logical. Should blocks be used for prior information? If priorB = TRUE, then the spatial structure in a block serves as prior information for the inner scale. If priorB = FALSE, then the blocks are only used to increase speed through parallelization, not for prior information. Defaults to FALSE.
domain	logical. Should the domain (i.e. the input raster) be used for prior information? If domain = TRUE, then it is used as prior for all inner moving windows. Defaults to FALSE.
dist	integer. The distance between two pixels that should be considered as a pair, defaults to dist = 1 (direct neighbors).
angle	string. The angle on which pixels should be considered as pairs. Takes 5 options: "horizontal", "vertical", "diagonal45", "diagonal135", "all". The direction-invariant version is "all", which considers all of the 4 angles. Defaults to "all".
rank	logical. Should pixel values be replaced with ranks in each GLCM? Defaults to FALSE.
fun	function, the structural diversity metric. Takes one of the following: entropy, entropyNorm, contrast, dissimilarity, or homogeneity. Structural diversity entropy is entropy with different delta parameters. Shannon entropy is employed when delta = 0. Shannon entropy has a scale-dependent maximum when strucDiv is used, but this maximum may be violated in strucDivNest,

when information from different scales is combined, depending on the posterior probabilities of pixel value co-occurrences. Additionally, the value gradient is considered with `delta = 1` and `delta = 2`. The values of structural diversity entropy with `delta = 1` or `delta = 2` are not restricted and depend on the values of the input raster. the metric `entropyNorm` is Shannon entropy normalized over maximum entropy, which depends on the size of the moving window when no scales are nested. When information from different scales is combined in `strucDivNest`, the metric `entropyNorm` may be larger than 1, depending on the posterior probabilities of pixel value co-occurrences. The metrics `contrast` and `dissimilarity` consider the value gradient, their values are not restricted and depend on the values of the input raster. The metric `homogeneity` quantifies the closeness of empirical probabilities to the diagonal and ranges between 0 and 1 when scales are not nested. When information from different scales is combined in `strucDivNest`, the metric `homogeneity` may be larger than 1, depending on the posterior probabilities of pixel value co-occurrences.

`delta` numeric, takes three options: `0`, `1`, or `2`. The `delta` parameter defines how the differences between pixel values within a pixel pair should be weighted. If `rank = TRUE`, delta defines how the differences between ranks should be weighted. Defaults to `0` (no weight). Set `delta = 1` for absolute weights, or `delta = 2` for square weights. The `delta` parameter can only be set when the metric `entropy` is used. the metric `dissimilarity` automatically employs `delta = 1`, and `contrast` employs `delta = 2`.

`na.handling` `na.omit` or `na.pass`. If `na.handling = na.omit`, NAs are ignored and structural diversity metrics are calculated with less values. If `na.handling = na.pass` and if there is at least one missing value inside the moving window, an NA is assigned to the center pixel. Therefore, the diversity map will contain more NAs than the input raster layer. Defaults to `na.pass`.

`padValue` numeric or `NA`. The value of the padded cells at the edges of the input raster. Defaults to `NA`.

`aroundTheGlobe` logical. If the input raster goes around the whole globe, set `aroundTheGlobe = TRUE`, and the input raster will be 'glued together' from both sides to calculate structural diversity without edge effects. Defaults to `FALSE`.

`ncores` integer. The number of cores the computation will be parallelized on. Parallelization is only available when blocks are used. i.e. dimB must be specified. Parallelization can be used independent of whether blocks are used as priors or not.

`verbose` logical. If `verbose = TRUE`, a progress bar will be visible.

`filename` character. If the output raster should be written to a file, define file name (optional).

`...` possible further arguments.

Details

The memory requirement of the function is determined by `raster::canProcessInMemory()`. If the raster file cannot be processed in memory, its size needs to be reduced before `strucDivNest` can be used.

Value

The output is a (spatial) structural diversity map, returned as a raster layer. If the outer scale is a moving window or the domain, then the output raster has the same dimensions as the input raster. If the outer scale is a block, then the output raster may be smaller than the input raster because if there are edges that do not fit inside the blocks, they are cut off. When `na.handling = na.pass`, then the output map will have an NA-edge of 0.5*(wslO-1), and it will contain more missing values than the input raster. The output represents spatial structural diversity quantified across different spatial scale, which are defined by the size of the inner and the outer scale.

Examples

```
## Not run:
# Construct a small raster file containing realizations of normal random variables:
a <- raster::raster(matrix(rnorm(400), 20, 20))
raster::plot(a)
# Calculate structural diversity entropy with delta = 2, double moving window scheme
sde_1 <- strucDivNest(a, wslI = 3, wslO = 5, angle = "horizontal", fun = entropy, delta = 2)
raster::plot(sde_1)

# Calculate structural diversity entropy with delta = 1, block nesting scheme
b <- raster::raster(matrix(rnorm(2500), 50, 50))
raster::plot(b)
sde_b <- strucDivNest(b, wslI = 3, dimB = c(10, 10), oLap = 4, priorB = TRUE, fun = entropy,
    delta = 1)
raster::plot(sde_b)

# Calculate entropy on simulated random patch, domain nesting scheme
patch <- raster::raster(patch)
entropy_patch <- strucDivNest(patch, wslI = 5, domain = TRUE, angle = "vertical", fun = entropy)
raster::plot(entropy_patch)

## End(Not run)
```

Index