# Package: heterogen (via r-universe)

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**Type** Package

**Title** Spatial Functions for Heterogeneity and Climate Variability

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**Description** A comprehensive suite of spatial functions created to analyze and assess data heterogeneity and climate variability in spatial datasets. This package is specifically designed to address the challenges associated with characterizing and understanding complex spatial patterns in environmental and climate-related data.

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**URL** https://github.com/patauchi/heterogen

**BugReports** https://github.com/patauchi/heterogen/issues

**NeedsCompilation** yes

**Depends** terra

**Imports** methods, rio, scales, future, parallel

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# Contents



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`bg_transpose` *bg_transpose*

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## Description

Transpose of a matrix based on row or column index.

## Usage

```
bg_transpose(mat, byrow = FALSE)
```

## Arguments

| | |
|---|---|
| `mat` | A Matrix. |
| `byrow` | `FALSE` computes based on row index. `TRUE` computes based on column index. |

## Value

A matrix transposed.

distance_weighted_gauss *distance_weighted_gauss*

## Description

Weighted Distance based on Gaussian function

## Usage

```
distance_weighted_gauss(coord_xy, point_xy, tau)
```

## Arguments

| | |
|---|---|
| coord_xy | A Matrix with lon/lat coordinates. |
| point_xy | lon/lat coordinate. |
| tau | bandwidth. |

## Value

A vector.

float_relative *float_relative*

## Description

Relative sum formula

## Usage

```
float_relative(xx)
```

## Arguments

| | |
|---|---|
| xx | A Matrix with lon/lat coordinates. |

## Value

A vector.

## float_round *float_round*

### Description

Rouding of Numbers

### Usage

```
float_round(float_n, digits = 0L)
```

### Arguments

| | |
|---|---|
| float_n | A numeric vector. |
| digits | integer indicating the number of decimal places . |

### Value

A vector.

## gwpca_core *Core Function of GWPCA*

### Description

The gwpca_core function is a core implementation of Generalized Weighted Principal Component Analysis for each iteration.

### Usage

```
gwpca_core(xy, p_xy, env, env_trans, tau)
```

### Arguments

| | |
|---|---|
| xy | A matrix containing the coordinates of the points where environmental measurements were taken. The matrix should have two columns, representing the X and Y coordinates. |
| p_xy | A matrix containing the coordinates of the point GWPCA will be estimated. It should have two columns for X and Y coordinates. |
| env | A data matrix representing the environmental variables. Rows represent observations (points or grid cells), and columns represent environmental variables. |
| env_trans | Transpose of env matrix. |
| tau | The bandwidth parameter for spatial weighting in GWPCA. It determines the extent of spatial influence on the estimation of principal components. |

## Value

A vector of eigenvalues from local PCA

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`gwpca_df_mc` *Perform GWPCA from data.frame with spatial structure.*

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## Description

gwpca_df is an R function that performs Generalized Weighted Principal Component Analysis (GWPCA) on a given dataset. This function allow to calculate the environmental heterogeneity from data.frame with spatial structure.

## Usage

```
gwpca_df_mc(
  datadf,
  bandwidth = 0.2,
  tolerance = 5,
  nprocess = 10000,
  parallel = FALSE,
  ncores = 2,
  normalized = FALSE,
  method = "iter",
  dirds = "rds"
)
```

## Arguments

| | |
|---|---|
| `datadf` | The input data matrix for which GWPCA needs to be performed. It should contain numerical values only. Rows represent cells, and columns represent bioclimatic variables. |
| `bandwidth` | The bandwidth for the spatial weighting function. |
| `tolerance` | The tolerance for spatial weight computation. |
| `nprocess` | (Optional) The number of iterations for calculating the principal components. Default is set to 1000. |
| `parallel` | (Optional) A logical value indicating whether to run the computation in parallel. If `TRUE`, multiple cores will be used for processing. Default is `FALSE`. |
| `ncores` | (Optional) The number of cores to be used for parallel computation. Only applicable if `parallel` is set to `TRUE`. Default is 4. |
| `normalized` | (Optional) A logical value indicating whether the input data should be normalized before performing GWPCA. Default is `FALSE`, meaning the data will not be normalized. Take in account that core function performs correlation analysis in order to normalize the input variables. |

| | |
|---|---|
| method | The method used for GWPCA computation. It can take one of the following values. local Performs GWPCA locally and will save each iteration on .rds files. Recommended for large-scale data sets. inter Uses RAM memory to . Default is inter. |
| dirds | (Optional) The directory where the results will be saved in RDS format. Default is rds. |

## Value

A matrix of eigenvalues

## Examples

```
path_csv <- system.file("extdata","south.csv", package="heterogen")
south_csv <- rio::import(path_csv)

# notice: south_csv object contains x,y (lot/lat coordinates)
# and environmental variables
north_het <- gwpca_df_mc(as.matrix(south_csv), parallel = TRUE,
ncores = 2, bandwidth = 0.1, tolerance = 10)
```

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# heterog *Heterogeneity (rasters)*

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## Description

The heterog function is designed to calculate environmental heterogeneity metric from a raster stack dataset. This function aids in assessing the spatial variation and diversity of environmental variables within the raster data, providing valuable insights into the heterogeneity of the study area.

## Usage

```
heterog(
  datastack,
  bandwidth = 0.3,
  tolerance = 5,
  nprocess = 1000,
  parallel = FALSE,
  ncores = 2,
  normalized = FALSE,
  method = "iter",
  dirds = "rds"
)
```

## Arguments

| | |
|---|---|
| datastack | SpatRaster class. The input raster stack representing environmental variables. Each layer in the stack corresponds to a different environmental variable, and the function calculates heterogeneity based on the variability across these layers. |
| bandwidth | The bandwidth for the spatial weighting function. |
| tolerance | The tolerance for spatial weight computation. |
| nprocess | (Optional) The number of iterations for calculating the principal components. Default is set to 1000. |
| parallel | (Optional) A logical value indicating whether to run the computation in parallel. If TRUE, multiple cores will be used for processing. Default is FALSE. |
| ncores | (Optional) The number of cores to be used for parallel computation. Only applicable if parallel is set to TRUE. Default is 4. |
| normalized | (Optional) A logical value indicating whether the input data should be normalized before performing GWPCA. Default is FALSE, meaning the data will not be normalized. Take in account that core function performs correlation analysis in order to normalize the input variables. |
| method | The method used for GWPCA computation. It can take one of the following values. local Performs GWPCA locally and will save each iteration on .rds files. Recommended for large-scale data sets. inter Uses RAM memory to . Default is inter. |
| dirds | (Optional) The directory where the results will be saved in RDS format. Default is rds. |

## Value

A SpatHetero object

- hetero A heterogeneity layer
- matrix A Matrix of eigenvalues
- rasters A complete set of heterogeneity layers for each component

## Examples

```
# Case 01: South
path <- system.file("extdata","south", package="heterogen")
south_rast <- terra::rast(list.files(path, full.names = TRUE,
pattern = '.tif'))

south_het <- heterog(south_rast, parallel = TRUE,
bandwidth = 0.1, tolerance = 10)
plot(south_het)



# Case 02: North
path <- system.file("extdata","north", package="heterogen")
north_rast <- terra::rast(list.files(path, full.names = TRUE,
```

```
pattern = '.tif'))

north_het <- heterog(north_rast, parallel = TRUE,
bandwidth = 0.1, tolerance = 10)
plot(north_het)
```

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`matrixcec_square` *matrixcec_square*

---

## Description

Matrix Square

## Usage

```
matrixcec_square(X, y)
```

## Arguments

| | |
|---|---|
| `X` | A Matrix. |
| `y` | A Vector |

## Value

A matrix.

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`matrixmult` *matrixmult*

---

## Description

Matrix Multiplication

## Usage

```
matrixmult(A, B)
```

## Arguments

| | |
|---|---|
| `A` | A Matrix. |
| `B` | A Matrix |

## Value

A matrix.

## matrixvec_plus *matrixvec_plus*

### Description

Matrix Multiplication

### Usage

```
matrixvec_plus(X, y)
```

### Arguments

| | |
|---|---|
| X | A Matrix. |
| y | A Vector |

### Value

A matrix.

## matrixvec_subs *matrixvec_subs*

### Description

Matrix Substraction

### Usage

```
matrixvec_subs(X, y)
```

### Arguments

| | |
|---|---|
| X | A Matrix. |
| y | A Vector |

### Value

A matrix.

`plot,SpatHetero,ANY-method` *Plot Heterogeneity Layer*

## Description

Plot

## Usage

```
## S4 method for signature 'SpatHetero,ANY'
plot(x, comp = NULL, ...)
```

## Arguments

| | |
|---|---|
| `x` | SpatHetero Class |
| `comp` | integer. Plot specific component of the heterogeneity. |
| `...` | Plot parameters forwarded. |

## Value

No return value, called for side effects.

`SpatHetero-class` *SpatHetero*

## Description

SpatHetero

## Slots

`hetero` A Heterogeneity Layer

`matrix` SpatHetero_in data

`rasters` A SpatRaster for Each Component

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