Package: pycnogrid (via r-universe)

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Title Flexible Pycnophylactic Interpolation to Discrete Global and Local Grid Systems

Version 0.2.1

Description Provides tools for pycnophylactic interpolation of polygon totals to discrete global and local grid systems. The method follows Tobler (1979) <doi:10.1080/01621459.1979.10481647>. Centroid-based allocation preserves represented source-zone totals while smoothing values across neighboring target cells. Fractional area-based allocation is experimental and preserves the overall represented total but may not preserve individual source-zone totals.

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`pycnogrid-package` *pycnogrid*

Description

Provides tools for pycnophylactic interpolation of polygon totals to discrete global and local grid systems. The method follows Tobler (1979) doi:10.1080/01621459.1979.10481647. Centroid-based allocation preserves represented source-zone totals while smoothing values across neighboring target cells. Fractional area-based allocation is experimental and preserves the overall represented total but may not preserve individual source-zone totals.

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See Also

Useful links:

- https://higgicd.github.io/pycnogrid/
- https://github.com/higgicd/pycnogrid
- Report bugs at https://github.com/higgicd/pycnogrid/issues

nyc_ct *New York City census tract example data*

Description

Census tract population and employment data for New York City.

Usage

```
nyc_ct
```

Format

An sf object with:

id Census tract GEOID

populationE Estimated total population

employment Total employment

geometry MULTIPOLYGON geometry

Details

Population data were obtained from the American Community Survey using the tidycensus package. Employment data were obtained from LEHD LODES using the lehdr package.

Source

U.S. Census Bureau American Community Survey 2023 5-year estimates; LEHD LODES 2022. This product uses Census Bureau data but is not endorsed or certified by the Census Bureau.

nyc_ct_small *Small New York City census tract example data*

Description

A small contiguous subset of NYC census tracts for examples and testing.

Usage

```
nyc_ct_small
```

Format

An sf object with the same columns as `nyc_ct`.

Source

American Community Survey 2023; LEHD LODES 2022. This product uses Census Bureau data but is not endorsed or certified by the Census Bureau.

`to_a5` *Pycnophylactic interpolation to an A5 grid*

Description

Interpolates polygon counts to an A5 grid while preserving source-zone totals when used with default centroid-based allocation.

Usage

```
to_a5(source, value_col, resolution, ...)
```

Arguments

`source`	An `sf` polygon object in a projected CRS.
`value_col`	Column containing the values to interpolate. May be supplied as an unquoted column name or a character string.
`resolution`	A5 resolution level (0–30). Higher values produce smaller cells and many more output polygons. For typical urban analyses, values around 8–16 are usually more practical.
`...`	Additional arguments passed to `to_grid()`.

Details

A5 is a hierarchical global discrete grid system in which each increase in resolution subdivides cells by a factor of five. Consequently, the number of cells grows exponentially with resolution and very high resolutions may be impractical for pycnophylactic interpolation.

Calls `to_grid()` with `grid_type = "a5"`.

Value

An `sf` object containing A5 cells and interpolated values.

Examples

```
out <- to_a5(
  source = nyc_ct_small,
  value_col = populationE,
  resolution = 15,
  max_iter = 5
)
```

to_grid *Pycnophylactic interpolation to a grid*

Description

Interpolates polygon counts to a regular or global discrete grid. Centroid allocation preserves represented source-zone totals while smoothing densities across neighboring target cells. Areal allocation preserves global totals.

Usage

```
to_grid(
  source,
  value_col,
  id_col = NULL,
  grid_type = c("h3", "a5", "s2", "isea3h", "isea4h", "raster", "hex"),
  resolution,
  cell_inclusion = c("intersect", "centroid"),
  cell_allocation = c("centroid", "area"),
  nb_order = 1,
  max_iter = 500,
  tolerance = 1e-04,
  include_self = TRUE,
  missing_policy = c("abort", "warn", "ignore")
)
```

Arguments

source	An sf polygon object in a projected CRS.
value_col	Column containing the values to interpolate. May be supplied as an unquoted column name or a character string.
id_col	Optional unique identifier column for source polygons.
grid_type	Grid system to interpolate to. One of "h3", "a5", "s2", "isea3h", "isea4h", "raster", or "hex".
resolution	Grid resolution. For H3, A5, S2, and ISEA grids this is the grid level. For local raster and hex grids this is the cell size in the linear units of the input projected CRS.
cell_inclusion	Method used to determine which grid cells are included. One of "intersect" or "centroid".
cell_allocation	Method used to allocate source values to grid cells. "centroid", the default, assigns each target cell to the source polygon containing its centroid and preserves represented source-zone totals. "area" uses fractional source-cell overlap areas. Area allocation is experimental: it preserves the overall represented total but may not preserve each individual source-zone total.

nb_order	Neighbourhood order used for smoothing. A value of 1 uses first-order neighbours; larger values include higher-order neighbours.
max_iter	Maximum number of pycnophylactic smoothing iterations. If 0, returns the initial allocation without smoothing.
tolerance	Convergence tolerance based on relative mean density change.
include_self	Logical. Should each cell include itself when smoothing?
missing_policy	How to handle source polygons that receive no grid cells. One of "abort", "warn", or "ignore".

Details

With cell_allocation = "centroid", each represented target cell belongs to one source polygon. The correction step therefore preserves the total associated with each represented source zone.

With cell_allocation = "area", target cells may overlap several source polygons. The current fractional correction preserves the overall represented total but does not guarantee preservation of every individual source-zone total. This mode is experimental.

Value

An sf object containing grid-cell geometries and interpolated values.

Examples

```
out <- to_grid(
  source = nyc_ct_small,
  value_col = populationE,
  grid_type = "h3",
  resolution = 9,
  max_iter = 5
)
```

---

to_h3 *Pycnophylactic interpolation to an H3 grid*

Description

Interpolates polygon counts to an H3 grid while preserving source-zone totals when used with default centroid-based allocation.

Usage

```
to_h3(source, value_col, resolution, ...)
```

Arguments

source	An sf polygon object in a projected CRS.
value_col	Column containing the values to interpolate. May be supplied as an unquoted column name or a character string.
resolution	H3 resolution level (0–15). Higher values produce smaller cells and many more output polygons. For typical urban analyses, values around 9–12 are usually more practical.
...	Additional arguments passed to to_grid().

Details

H3 is a hierarchical global discrete grid system composed primarily of hexagonal cells. Higher resolution levels produce smaller cells and a larger number of output cells. H3 resolutions range from 0 to 15, but high resolutions may be impractical for large study areas.

Calls to_grid() with grid_type = "h3".

Value

An sf object containing H3 cells and interpolated values.

Examples

```
out <- to_h3(
  source = nyc_ct_small,
  value_col = populationE,
  resolution = 9,
  max_iter = 5
)
```

---

to_hex *Pycnophylactic interpolation to a local hexagonal grid*

Description

Interpolates polygon counts to a local hexagonal grid while preserving source-zone totals when used with default centroid-based allocation.

Usage

```
to_hex(source, value_col, resolution, ...)
```

Arguments

source	An sf polygon object in a projected CRS.
value_col	Column containing the values to interpolate. May be supplied as an unquoted column name or a character string.
resolution	Hexagonal cell size specified in the linear units of the input projected CRS.
...	Additional arguments passed to to_grid().

Details

Hex grids divide the study area into hexagonal cells of a fixed size. Smaller cell sizes produce more output cells and may substantially increase computation time.

Value

An sf object containing hexagonal grid-cell polygons and interpolated values.

Examples

```
out <- to_hex(
  source = nyc_ct_small,
  value_col = populationE,
  resolution = 250,
  max_iter = 5
)
```

---

to_isea *Pycnophylactic interpolation to an ISEA grid*

Description

Interpolates polygon counts to an ISEA discrete global grid while preserving source-zone totals when used with default centroid-based allocation.

Usage

```
to_isea(source, value_col, resolution, aperture = c(3, 4), ...)
```

Arguments

source	An sf polygon object in a projected CRS.
value_col	Column containing the values to interpolate. May be supplied as an unquoted column name or a character string.
resolution	ISEA resolution level. Higher values produce smaller cells and substantially more output polygons.
aperture	ISEA aperture: one of 3 or 4.
...	Additional arguments passed to to_grid().

Details

ISEA grids are equal-area hierarchical discrete global grid systems based on the Icosahedral Snyder Equal Area projection. The `aperture` determines the refinement factor between successive resolutions: aperture 3, 4, or 7.

Calls `to_grid()` with `grid_type` set to `"isea3h"` or `"isea4h"` according to `aperture`.

Value

An `sf` object containing ISEA cells and interpolated values.

Examples

```
out <- to_isea(
  source = nyc_ct_small,
  value_col = populationE,
  resolution = 19,
  aperture = 3,
  max_iter = 5
)

out <- to_isea(
  source = nyc_ct_small,
  value_col = populationE,
  resolution = 15,
  aperture = 4,
  max_iter = 5
)
```

---

to_raster *Pycnophylactic interpolation to a raster grid*

Description

Interpolates polygon counts to a regular raster grid while preserving source-zone totals when used with default centroid-based allocation.

Usage

```
to_raster(source, value_col, resolution, ...)
```

Arguments

`source`	An `sf` polygon object in a projected CRS.
`value_col`	Column containing the values to interpolate. May be supplied as an unquoted column name or a character string.
`resolution`	Raster cell size specified in the linear units of the input projected CRS.
`...`	Additional arguments passed to `to_grid()`.

Details

Raster grids divide the study area into regular cells of a fixed size. In `pycnogrid`, interpolation is performed using a raster grid, but results are returned as polygon grid cells in an `sf` object. Smaller cell sizes produce more output cells and may substantially increase computation time.

Value

An `sf` object containing raster grid-cell polygons and interpolated values.

Examples

```
out <- to_raster(
  source = nyc_ct_small,
  value_col = populationE,
  resolution = 250,
  max_iter = 5
)
```

---

to_s2 *Pycnophylactic interpolation to an S2 grid*

Description

Interpolates polygon counts to an S2 grid while preserving source-zone totals when used with default centroid-based allocation.

Usage

```
to_s2(source, value_col, resolution, ...)
```

Arguments

`source`	An `sf` polygon object in a projected CRS.
`value_col`	Column containing the values to interpolate. May be supplied as an unquoted column name or a character string.
`resolution`	S2 resolution level (0–30). Higher values produce smaller cells and many more output polygons. For typical urban analyses, values around 8–16 are usually more practical.
`...`	Additional arguments passed to `to_grid()`.

Details

S2 is a hierarchical global discrete grid system based on recursively subdividing the six faces of a cube projected onto the sphere. Higher cell levels produce smaller cells and a larger number of output cells. Very high levels may be impractical for pycnophylactic interpolation over large study areas.

Calls `to_grid()` with `grid_type = "s2"`.

Value

An `sf` object containing S2 cells and interpolated values.

Examples

```
out <- to_s2(
  source = nyc_ct_small,
  value_col = populationE,
  resolution = 15,
  max_iter = 5
)
```

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