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Title Beyond the Border - Kernel Density Estimation for Urban Geography

Description The kernelSmoothing() function allows you to square and smooth geolocated data. It calculates a classical kernel smoothing (conservative) or a geographically weighted median. There are four major call modes of the function. The first call mode is kernelSmoothing(obs, epsg, cellsize, bandwidth) for a classical kernel smoothing and automatic grid. The second call mode is kernelSmoothing(obs, epsg, cellsize, bandwidth, quantiles) for a geographically weighted median and automatic grid. The third call mode is kernelSmoothing(obs, epsg, cellsize, bandwidth, centroids) for a classical kernel smoothing and user grid. The fourth call mode is kernelSmoothing(obs, epsg, cellsize, bandwidth, quantiles, centroids) for a geographically weighted median and user grid. Geographically weighted summary statistics : a framework for localised exploratory data analysis, C.Brunsdon & al., in Computers, Environment and Urban Systems C.Brunsdon & al. (2002) <doi:10.1016/S0198-9715(01)00009-6>, Statistical Analysis of Spatial and Spatio-Temporal Point Patterns, Third Edition, Diggle, pp. 83-86, (2003) <doi:10.1080/13658816.2014.937718>.

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btb

Beyond the Border - Kernel Density Estimation for Urban Geography

Description

The `kernelSmoothing()` function allows you to square and smooth geolocated data. It calculates a classical kernel smoothing (conservative) or a geographically weighted median. There are four major call modes of the function. The first call mode is `kernelSmoothing(obs, epsg, cellsize, bandwidth)` for a classical kernel smoothing and automatic grid. The second call mode is `kernelSmoothing(obs, epsg, cellsize, bandwidth, quantiles)` for a geographically weighted median and automatic grid. The third call mode is `kernelSmoothing(obs, epsg, cellsize, bandwidth, centroids)` for a classical kernel smoothing and user grid. The fourth call mode is `kernelSmoothing(obs, epsg, cellsize, bandwidth, quantiles, centroids)` for a geographically weighted median and user grid.

 btb_add_centroids *Link points to their centroids*

Description

- Link some points to their centroids in a grid segmentation
- Relie des points aux centroides des carreaux auxquels ces points appartiennent (dans un découpage de l'espace en grille carroyée)

Usage

```
btb_add_centroids(
  pts,
  iCellSize,
  offset = c(0L, 0L),
  names_coords = c("x", "y"),
  names_centro = c("x_centro", "y_centro"),
  add = TRUE
)
```

Arguments

pts	:	points (df of sf object)
iCellSize	:	<ul style="list-style-type: none"> • Size of the square cells (meters) • Taille des côtés des carreaux (mètres)
offset		(numeric vector of size 2) <ul style="list-style-type: none"> • Offset for a grid non centered on the geographical referential origin • Décalage si utilisation d'une grille non centrée sur l'origine du référentiel géographique
names_coords	:	<ul style="list-style-type: none"> • Names of the latitude-longitude variables (character vector) • Noms des variables de latitude-longitude (vecteur character)
names_centro		<ul style="list-style-type: none"> • Names of the latitude-longitude variables for added centroids (character vector) <ul style="list-style-type: none"> – Noms des variables de latitude-longitude pour les centroïdes ajoutés (vecteur character)
add		(boolean) <ul style="list-style-type: none"> • If TRUE : returns pts + centroids coordinates • Si TRUE : retourne pts + les coordonnées des centroïdes

Details

Works with sf points but only with coordinates in meters (and not degrees !). Do not use sf points with GPS coordinates for example.

Value

- pts table with additional centroids coordinates x_centro and y_centro (df of sf object)
- Table pts avec les coordonnées des centroïdes x_centro and y_centro (objet df of sf)

Examples

```
pts <- data.frame(
  x = c(656913.1 , 348296.3 , 842276.3 , 716750.0 , 667418.2),
  y = c(6855995 , 6788073 , 6385680 , 7003984 , 6585793),
  val = 1:5)
btb_add_centroids(pts, 100, names_centro = c("centroX", "centroY"))
btb_add_centroids(pts, 100, offset = c(50, 50), names_centro = c("centroX", "centroY"))
pts2 <- sf::st_as_sf(pts, coords = c("x","y"), crs = 2154)
btb_add_centroids(pts2, 50)
```

btb_add_inspire	<i>Creates Inspire names for a grid</i>
-----------------	---

Description

Creates Inspire names for a grid defined with :

- centroids coordinates
- Squares size(s)
- Projection system

Ajoute les noms des identifiants en norme Inspire des carreaux définis à partir :

- des coordonnées de leurs centroïdes
- de la taille de leur côté en mètres
- d'un système de projection)

Usage

```
btb_add_inspire(
  pts_centro,
  sEPSG,
  iCellSize,
  names_centro = c("x_centro", "y_centro")
)
```

Arguments

pts_centro	(df object) : table of centroids.
sEPSG	(integer or character) : epsg code.
iCellSize	(integer) : cells size(s) in meters. Can be a vector for irregular grids
names_centro	(character vector) : vector of names for longitude/latitude variables. Default c("x_centro","y_centro").

Value

(df) pts_centro table with additional *idInspire* variable

Examples

```
pts_centro <- data.frame(x_centro = c(100, 100, 300, 300, 500),
  y_centro = c(100, 300, 100, 300, 100))
btb_add_inspire(pts_centro, sEPSG = 2154, iCellSize = 200)
```

btb_ptsToGrid	<i>Compute a grid from centroid points</i>
---------------	--

Description

Function to compute a grid (regular or not) from centroid points.

(Fonction permettant de générer une grille (régulière ou non) à partir de centroïdes)

Usage

```
btb_ptsToGrid(
  pts,
  sEPSG = NA,
  iCellSize = NULL,
  names_centro = c("x_centro", "y_centro"),
  inspire = F
)
```

Arguments

pts	A simple data.frame with the centroids coordinates of the squares to draw, or a sf object of centroides. To generate an irregular grid, a column with each cell size must be provided and named iCellSize. (Un simple data.frame comportant les coordonnées des carrés à dessiner, ou un objet sf des centroides. Pour obtenir une grille irrégulière, il faut fournir une colonne indiquant la taille de chaque carreau, et nommée iCellSize.)
sEPSG	EPSG code of projection (character). For example, the RGF93 / Lambert-93 projection has "2154" code. (code EPSG de la projection (character). Par exemple, la projection RGF93 / Lambert-93 a pour code "2154".)
iCellSize	Cell size of the grid. If this argument is provided, the grid is regular. (Taille des carreaux de la grille. Si cet argument est fourni, la grille est régulière.)
names_centro	(character vector) <ul style="list-style-type: none"> • vector of names for longitude/latitude variables. Default c("x_centro","y_centro"). • vecteur des noms des variables de longitude/latitude. Par défaut : c("x_centro","y_centro")
inspire	(boolean) : if TRUE, returns a column for Inspire grid names.

Value

Returns an object of class `sf` and `data.frame`.

(Retourne un objet de classe `sf` et `data.frame`.)

Examples

```
# example 1 - regular grid
pts <- data.frame(x_centro = c(100, 100, 300, 300, 500),
  y_centro = c(100, 300, 100, 300, 100))
carResult <- btb_ptsToGrid(pts = pts, sEPSG = "2154", iCellSize = 200)
# write_sf(obj = carResult, dsn = "regularGrid.shp", delete_layer = TRUE)

# example 2 - irregular grid
pts <- data.frame(x = c(50, 50, 150, 150, 300)
  , y = c(50, 150, 50, 150, 100)
  , iCellSize = c(50, 50, 50, 50, 100))
carResult <- btb_ptsToGrid(pts = pts, sEPSG = "2154", names_centro=c("x","y"))
# write_sf(obj = carResult, dsn = "irregularGrid.shp", delete_layer = TRUE)
# Exemple 3 : sf points (no epsg)
pts <- data.frame(x = c(100, 100, 300, 300, 500), y = c(100, 300, 100, 300, 100))
pts <- sf::st_as_sf(pts, coords=c("x","y"))
carResult <- btb_ptsToGrid(pts = pts, sEPSG = "2154", iCellSize = 200)
# Exemple 3 : sf points (no epsg)
pts <- data.frame(x = c(100, 100, 300, 300, 500),
  y = c(100, 300, 100, 300, 100))
pts <- sf::st_as_sf(pts, coords=c("x","y"), crs=2154)
carResult <- btb_ptsToGrid(pts = pts, sEPSG = "2154", iCellSize = 200)
```

btb_smooth

Smoothing with a bisquare kernel or median

Description

Smoothing function with a bisquare kernel or median.

(Fonction de lissage à partir d'un noyau bisquare ou de la médiane.)

Usage

```
btb_smooth(
  pts,
  sEPSG = NA,
  iCellSize = NA,
  iBandwidth,
  vQuantiles = NULL,
  dfCentroids = NULL,
  iNeighbor = NULL,
  inspire = F,
  iNbObsMin = 250
)
```

Arguments

pts	<p>A data.frame with cartesian geographical coordinates and variables to smooth. (x, y, var1, var2, ...)</p> <p>(Un data.frame comportant les coordonnées géographiques cartésiennes (x,y), ainsi que les variables que l'on souhaite lisser. (x, y, var1, var2, ...))</p>
sEPSG	<p>EPSG code of projection (character). For example, the RGF93 / Lambert-93 projection has "2154" code.</p> <p>(code EPSG de la projection (character). Par exemple, la projection RGF93 / Lambert-93 a pour code "2154").</p>
iCellSize	<p>Cell size of the grid (integer). The unit of measurement is free. It must be the same as the unit of iBandwidth variable.</p> <p>(Taille des carreaux (integer). Le choix de l'unité de mesure est laissé libre à l'utilisateur. Elle doit seulement être la même que celle de la variable iBandwidth.)</p>
iBandwidth	<p>Radius of the Kernel Density Estimator (integer). This bandwidth acts as a smoothing parameter, controlling the balance between bias and variance. A large bandwidth leads to a very smooth (i.e. high-bias) density distribution. A small bandwidth leads to an unsmooth (i.e. high-variance) density distribution. The unit of measurement is free. It must be the same as the unit of iCellSize variable.</p> <p>(Rayon de lissage de l'estimation d'intensité par noyau (integer). Cette bande-passante se comporte comme un paramètre de lissage, contrôlant l'équilibre entre biais et variance. Un rayon élevé conduit à une densité très lissée, avec un biais élevé. Un petit rayon génère une densité peu lissée avec une forte variance. Le choix de l'unité de mesure est laissé libre à l'utilisateur. Elle doit seulement être la même que celle de la variable iCellSize.)</p>
vQuantiles	<p>Percentile vector to calculate. For example c(0.1, 0.25, 0.5) will calculate the first decile, the first quartile and the median.</p> <p>(Vecteur des quantiles à calculer. Par exemple c(0.1, 0.25, 0.5) retournera le premier décile, le premier quartile et la médiane.)</p>
dfCentroids	<p>A data.frame with two columns (x, y) containing coordinates of the user's centroids. The coordinates must be in the same projection than (pts).</p> <p>(Un data.frame avec deux colonnes (x, y) contenant les coordonnées des centroides de l'utilisateur. Les coordonnées doivent être dans le même système de coordonnées que (pts).)</p>
iNeighbor	<p>Technical parameter, leave empty. (integer)</p> <p>(Paramètre technique pour calculer l'étendue des points d'estimations, à ne pas remplir. (integer))</p>
inspire	<p>(boolean) : if TRUE, returns a column for Inspire grid names.</p>
iNbObsMin	<p>Minimum size of constituted grappes for median smoothing. (integer)</p> <p>(Taille minimale des grappes constituées pour le lissage "médian" (géographiquement pondéré). (integer))</p>

Details

Returns an object inheriting from the `data.frame` class. (Retourne un objet qui se comporte comme un `data.frame`, par héritage.)

- Smoothing covers a set of methods to extract pertinent and structuring information from noisy data. In the field of spatial analysis, and most widely in quantitative geography, smoothing is used to modelise density variations of a population distribution in geographical space. Kernel smoothing methods are widely used. In this method, for each location x , we count the number of events of a process within a distance h of x , and weighted by the square reciprocal of the radius h . We apply a edge-correction to deal with edge-effects. So the method is conservative..
- Le lissage recouvre un ensemble de méthodes pour extraire d'une source de données bruitées une information pertinente et structurante. Dans le champ de l'analyse spatiale et plus largement de la géographie quantitative, le lissage est principalement utilisé pour modéliser les variations de densités d'une distribution de population dans l'espace géographique. On utilise principalement des méthodes de lissage par noyau. Il s'agit ici, pour chaque point x , de comptabiliser le nombre d' "événements" d'un processus à une distance h de ce point, tout en pondérant ce nombre par l'inverse de la distance h au carré. On applique une correction à la pondération afin de traiter les effets de bord. Cette méthode est conservative.

References

- "Geographically weighted summary statistics : a framework for localised exploratory data analysis", C.Brunsdon & al., in *Computers, Environment and Urban Systems* 2002
- *Statistical Analysis of Spatial and Spatio-Temporal Point Patterns*, Third Edition, Diggle, 2003, pp. 83-86

Examples

```
## Not run:
# Example 1
data(dfPrix_SP95_2016)
dfPrix_SP95_2016$nbObs <- 1L
dfSmoothed <- btb::btb_smooth(pts = dfPrix_SP95_2016,
                             sEPSG = "2154",
                             iCellSize = 5000L,
                             iBandwidth = 30000L,
                             inspire = TRUE)
dfSmoothed$prix95 <- dfSmoothed$SP95 / dfSmoothed$nbObs * 100
library(mapsf)
mf_map(dfSmoothed,
       type = "choro",
       var = "prix95",
       breaks = "fisher",
       nbreaks = 5,
       border = NA,
       leg_title = "prix du SP95 en centimes")
# Example 2
data(reunion)
# Call mode 1: classic smoothing - automatic grid
reunionSmoothed <- btb_smooth( pts = reunion,
```



```
                                sEPSG = "32740",
                                iCellSize = 200L,
                                iBandwidth = 400L)

library(mapsf)
mf_map(reunionSmoothed,
       type = "choro",
       var = "houhold",
       breaks = "fisher",
       nbreaks = 5,
       border = NA)
# Call mode 2: median smoothing - automatic grid
reunionSmoothed <- btb_smooth( pts = reunion,
                              sEPSG = "32740",
                              iCellSize = 200L,
                              iBandwidth = 400L,
                              vQuantiles = c(0.1, 0.5, 0.9))

mf_map(reunionSmoothed,
       type = "choro",
       var = "houhold_05",
       breaks = "fisher",
       nbreaks = 5,
       border = NA)
# Call mode 3: classic smoothing - user grid
dfCentroidsUser <- merge( x = seq(from = 314400L, to = 378800L, by = 200L),
                          y = seq(from = 7634000L, to = 7691200L, by = 200L))
reunionSmoothed <- btb_smooth( pts = reunion,
                              sEPSG = "32740",
                              iCellSize = 200L,
                              iBandwidth = 400L,
                              dfCentroids = dfCentroidsUser)
reunionSmoothed <- reunionSmoothed[reunionSmoothed$houhold > 0, ]
mf_map(reunionSmoothed,
       type = "choro",
       var = "houhold",
       breaks = "fisher",
       nbreaks = 5,
       border = NA)
# Call mode 4: median smoothing - user grid
reunionSmoothed <- btb_smooth( pts = reunion,
                              sEPSG = "32740",
                              iCellSize = 200L,
                              iBandwidth = 400L,
                              vQuantiles = c(0.1, 0.5, 0.9),
                              dfCentroids = dfCentroidsUser)
reunionSmoothed <- reunionSmoothed[reunionSmoothed$nbObs > 0, ]
mf_map(reunionSmoothed,
       type = "choro",
       var = "houhold_05",
       breaks = "fisher",
       nbreaks = 5,
       border = NA)

## End(Not run)
```

constituerGrappes *constituerGrappes*

Description

Quadtree variant function.
(Variante de la fonction Quadtree.)

Usage

```
constituerGrappes(iNbObsMin, mEffectifs)
```

Arguments

- | | |
|------------|---|
| iNbObsMin | <ul style="list-style-type: none">• An integer representing the minimum number of elements in each cluster<ul style="list-style-type: none">– Un <code>data.frame</code> représentant le nombre minimum d'éléments dans chaque grappe.) |
| mEffectifs | <ul style="list-style-type: none">• staffing matrix for each cell (<code>matrix</code>).<ul style="list-style-type: none">– matrice des effectifs pour chaque case (<code>matrix</code>). .) |

Value

- Returns a `matrix` with the cluster number for each cell .
- Retourne une `matrix` avec le numéro de grappe pour chaque cellule.

Author(s)

- Psar Analyse Urbaine Insee
- Arlindo Dos Santos
- Francois Semecurbe

constituerMatriceEffectifs
constituerMatriceEffectifs

Description

Function constituting a membership matrix (Fonction constituant une matrice des effectifs)

Usage

```
constituerMatriceEffectifs(vLigneObservation, vColonneObservation)
```

Arguments

vLigneObservation

:

- A vector containing the line number of each observation
- (Un vector contenant le numéro de ligne de chaque observation.)

vColonneObservation

:

- A vector containing the column number of each observation
- (Un vector contenant le numéro de colonne de chaque observation.)

Value

Returns a matrix with the number of observations for each cell.

(Retourne une matrix avec le nombre d'observations pour chaque cellule.)

Author(s)

- Psar Analyse Urbaine Insee
- Arlindo Dos Santos
- Francois Semecurbe

`dfPrix_SP95_2016`*Unleaded 95 price in France in 2016*

Description

Unleaded 95 price in France in 2016 (prix du sans-plomb 95 en France en 2016)

Usage`dfPrix_SP95_2016`**Format**`dfPrix_SP95_2016:`

A data frame with 5,573 rows and 3 columns:

x longitude

y latitude

SP95 Unleaded price - prix du sans plomb

Source

<https://www.prix-carburants.gouv.fr/rubrique/opendata/>

dfRestaurantParis *Parisian restaurants*

Description

Parisian restaurants (Restaurants parisiens)

Usage

dfRestaurantParis

Format

dfRestaurantParis:

A data frame with 13,823 rows and 17 columns:

x longitude

y latitude

french French restaurant

asian asian restaurant

caribbean caribbean restaurant

maghreb maghreb restaurant

african african restaurant

european european restaurant

south_america south_american restaurant

indian indian restaurant

world world food restaurant

cafeteria cafeteria restaurant

tea_house tea_house

brasserie brasserie restaurant

fastfood fastfood restaurant

bar bar

restaurant restaurant

Source

source : <https://opendata.paris.fr>

dfToGrid	<i>Deprecated function of btb_ptsToGrid</i>
----------	---

Description

Function dfToGrid has been replaced by btb_ptsToGrid

Usage

```
dfToGrid(df, sEPSG, iCellSize = NULL)
```

Arguments

df	centroid points
sEPSG	epsg code
iCellSize	cell size

Value

a grid

kernelSmoothing	<i>Deprecated function of btb_smooth</i>
-----------------	--

Description

Function kernelSmoothing has been replaced by btb_smooth

Usage

```
kernelSmoothing(  
  dfObservations,  
  sEPSG,  
  iCellSize,  
  iBandwidth,  
  vQuantiles = NULL,  
  dfCentroids = NULL,  
  fUpdateProgress = NULL,  
  iNeighbor = NULL,  
  iNbObsMin = 250  
)
```

Arguments

dfObservations	points
sEPSG	epsg code
iCellSize	cell size
iBandwidth	smoothing bandwidth
vQuantiles	quantiles
dfCentroids	user grid
fUpdateProgress	message parameter
iNeighbor	number of neighbors pixels
iNbObsMin	technical parameter

Value

a warning message

pixel_france	<i>France grid with 1km square tiles</i>
--------------	--

Description

Whole France grid with 1km square tiles. Lambert 93 projection.

(Grille France entière avec des carreaux d'1km de côté. Projection Lambert 93)

Usage

pixel_france

Format

pixel_france:

A data frame with 54,8495 rows and 2 columns:

x longitude of pixel's centroids

y latitude of pixel's centroids

Source

source : <https://opendata.paris.fr>

reunion	<i>Households of Reunion</i>
---------	------------------------------

Description

Households of Reunion (Menages de La Reunion) Gridded database with a grid cell resolution of 200 meters. (Données carroyées à 200 mètres).

Usage

reunion

Format

reunion:

A data frame with 14,076 rows and 4 columns:

x longitude

y latitude

houhold number of households - nombre de ménages

phouhold number of poor households - nombre de ménages pauvres

Source

Source : Insee, Localized data : Fiscal Revenue - 31/12/2010 and Housing Tax - 01/01/2011

Source : Insee, Revenus Fiscaux Localisés (RFL) au 31 decembre 2010 et Taxe d'habitation (TH) au 1er janvier 2011)

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