

Package ‘MTA’

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Title Multiscalar Territorial Analysis

Version 0.2.0

Description Build multiscalar territorial analysis based on various contexts.

License GPL-3

URL <https://github.com/riatelab/MTA/>

BugReports <https://github.com/riatelab/MTA/issues/>

LazyData true

Depends R (>= 3.5)

Imports methods, stats, sp, igraph, sf, cartography

Suggests knitr, rmarkdown, ineq, png, reshape2

VignetteBuilder knitr

Encoding UTF-8

RoxygenNote 6.1.1

NeedsCompilation no

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cardist	<i>Time Distance Matrix Between Communes</i>
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Description

Travel time between Grand Paris Metropole communes' centroids by car, in minutes.
Row names and column names match the DEPCOM field in [com](#).

Source

The matrix is computed using the osrm package (<https://cran.r-project.org/package=osrm>).
Data (c) OpenStreetMap contributors, ODbL 1.0. <http://www.openstreetmap.org/copyright>
Routes: OSRM. <http://project-osrm.org/>

Examples

```
data(GrandParisMetropole)
cardist[1:10,1:10]
```

com	<i>Grand Paris Metropole Communes Data</i>
-----	--

Description

Data on the Grand Paris Metropole communes, included in a sf object.

Format

A data frame with 150 rows and 10 variables:

DEPCOM Commune identifiers
LIBCOM Commune names
EPT EPT identifiers of the commune
LIBEPT EPT names of the commune
DEP Identifiers of the departement
INC Amount of income tax reference (in euros)
TH Number of tax households
geometry Commune geometry

Source

Direction générale des finances publiques, income tax 2014 (2013 incomes):

http://www.impots.gouv.fr/portal/dgi/public/statistiques.impot?espId=-4&pageId=stat_donnees_detaillees&sfid=4503

Atelier parisien d'urbanisme, Grand Paris communal composition (2015-12-17):

<http://www.apur.org/article/composition-12-territoires-metropole-grand-paris>

Examples

```
data(GrandParisMetropole)
head(com)
```

ept

Grand Paris Metropole EPTs

Description

sf object. Grand Paris Metropole EPTs. EPTs (Etablissements Publics Territoriaux) are groups of communes.

Format

EPT EPT identifiers

LIBEPT EPT names

Source

Atelier parisien d'urbanisme, Grand Paris communal composition (2015-12-17):

<http://www.apur.org/article/composition-12-territoires-metropole-grand-paris>

Examples

```
library(sf)
data(GrandParisMetropole)
plot(st_geometry(ept))
```

gdev

*General Deviation***Description**

Compute the deviation of each territorial unit as regards to all the study area (or a reference value).

Usage

```
gdev(x, var1, var2, type = "rel", ref)
```

Arguments

x	a data.frame, an sf object or a SpatialPolygonsDataFrame, including var1 and var2.
var1	name of the numerator variable in x.
var2	name of the denominator variable in x.
type	type of deviation; "rel" for relative deviation, "abs" for absolute deviation (see Details).
ref	ratio of reference; if missing, the ratio of reference is the one of the whole study area ($\text{sum}(\text{var1}) / \text{sum}(\text{var2})$).

Details

The relative global deviation is the ratio between var1/var2 and ref ($100 * (\text{var1} / \text{var2}) / \text{ref}$). Values greater than 100 indicate that the unit ratio is greater than the ratio of reference. Values lower than 100 indicate that the unit ratio is lower than the ratio of reference.

The absolute global deviation is the amount of numerator that could be moved to obtain the ratio of reference on all units. ($(\text{var1} - (\text{ref} * \text{var2}))$).

Value

A vector is returned.

Examples

```
library(sf)
library(cartography)
# load data
data("GrandParisMetropole")

# compute absolute global deviation
com$gdevabs <- gdev(x = com, var1 = "INC", var2 = "TH", type = "abs")
# compute relative global deviation
com$gdevrel <- gdev(x = com, var1 = "INC", var2 = "TH", type = "rel")

# Deviations maps
```

```

# set graphical parameters
par(mar = c(0,0,1.2,0))
# set breaks
bks <- c(min(com$gdevrel),50,75,100,125,150,max(com$gdevrel))
# set color palette
cols <- carto.pal(pal1 = "blue.pal", n1 = 3,
                  pal2 = "wine.pal", n2 = 3)
# plot a choropleth map of the relative global deviation
choroLayer(x = com, var = "gdevrel",
           legend.pos = "topleft",
           legend.title.txt = "Relative Deviation\n(100 = general average)",
           breaks = bks, border = NA,
           col = cols)
# add symbols proportional to the absolute general deviation
com$sign <- ifelse(test = com$gdevabs<0, yes = "negative", no = "positive")
propSymbolsTypoLayer(x = com, var = "gdevabs",var2 = "sign",
                    legend.var.pos = "left",legend.values.rnd = -2,
                    legend.var2.values.order = c("positive", "negative"),
                    legend.var.title.txt = "Absolute Deviation\n(Income redistribution)",
                    col = c("#ff000050","#0000ff50"),legend.var2.pos = "n",
                    legend.var.style = "e", inches = 0.2)
# add EPT boundaries
plot(st_geometry(ept), add=TRUE)
# add a layout
layoutLayer(title = "General Deviation (reference: Grand Paris Metropole)",
            sources = "GEOFLA® 2015 v2.1, Apur, impots.gouv.fr",
            north = TRUE, scale = 5, tabtitle = TRUE, frame = FALSE, theme = "red.pal",
            author = "MTA")

```

mapmst

Map Multiscalar Typology

Description

Map the multiscalar typology according to the three relative deviations (general: G, territorial: T and spatial: S). The elementary units are classified in eight classes according to their three relative positions and they are mapped with appropriate colors.

Usage

```

mapmst(x, var1, var2, ref, key, order, dist, mat, xid, threshold,
       superior = FALSE, colNA = "white", border = "grey80", lwd = 0.2,
       upborder = "black", uplwd = "1", add = FALSE)

```

Arguments

x	an sf object or a SpatialPolygonsDataFrame including var1 and var2.
var1	name of the numerator variable in x.
var2	name of the denominator variable in x.

ref	ratio of reference; if missing, the ratio of reference is the one of the whole study area ($\text{sum}(\text{var1}) / \text{sum}(\text{var2})$).
key	aggregation key field for measuring the deviation (intermediate territorial level).
order	contiguity order.
dist	distance threshold defining the contiguity. The cartesian distance between units centroids is used by default ; use <code>mat</code> to apply different metrics.
mat	a distance matrix (road distance, travel time...) between <code>x</code> units. Row and column names must fit <code>xid</code> identifiers. (optional)
xid	identifier field in <code>x</code> (to be used for importing a personal distance matrix). Default to the first column.
threshold	defined to build the typology (100 is considered as the average).
superior	if TRUE, deviation values must be greater than threshold. If FALSE, deviation values must be lower than threshold.
colNA	no data color
border	color of the polygons border
lwd	borders width
upborder	color of the intermediate territorial level border
uplwd	intermediate territorial level border width
add	whether to add the layer to an existing plot (TRUE) or not (FALSE)

Value

A typology map with colours and a `sf` object including the ratio ($\text{var1}/\text{var2}$), the 3 relative deviations (G, T and S) and the resulting ordered typology (0 to 7).

Typology (which deviation is above/under the threshold):

- 0: none
- 1: G
- 2: T
- 3: G and T
- 4: S
- 5: G and S
- 6: T and S
- 7: G, T and S

Examples

```
library(sf)
library(cartography)
data("GrandParisMetropole")
# Map wealthiest territories
synthesis <- mapmst(x = com, var1 = "INC", var2 = "TH", key = "EPT",
                    order = 1, threshold = 125, superior = TRUE)
# add a layout and adapted legend
```

```

layoutLayer(title = "Multiscalar synthesis - Income per household 2013",
            sources = "GEOFLA® 2015 v2.1, Apur, impots.gouv.fr",
            north = TRUE, scale = 5, tabtitle = TRUE, frame = FALSE, theme = "red.pal",
            author = "MTA")
100: Deviation average
G: Situation as compared to the global context (Grand Paris Area)
T: Situation as compared to the territorial context (EPT of belonging)
S: Situation as compared to the neighbourhood context (contiguity order 1)")
# add label territorial objects above 125% for all the deviations
labelLayer(x = synthesis[synthesis$mst == 7, ], txt = "LIBCOM", cex = 0.6,
           halo = TRUE, overlap = FALSE)

# Map poorest territories
synthesis <- mapmst(x = com, var1 = "INC", var2 = "TH", key = "EPT",
                  order = 1, threshold = 75, superior = FALSE)

# add a layout
layoutLayer(title = "Multiscalar synthesis - Income per household 2013",
            sources = "GEOFLA® 2015 v2.1, Apur, impots.gouv.fr",
            north = TRUE, scale = 5, tabtitle = TRUE, frame = FALSE, theme = "red.pal",
            author = "MTA")
100: Deviation average
G: Situation as compared to the global context (Grand Paris Area)
T: Situation as compared to the territorial context (EPT of belonging)
S: Situation as compared to the neighbourhood context (contiguity order 1)")

# add labels for territorial objects under 75 % for all the deviations
labelLayer(x = synthesis[synthesis$mst == 7, ], txt = "LIBCOM", cex = 0.6,
           halo = TRUE)

```

mas

Multiscalar Absolute Synthesis

Description

This function sums the total amount of redistributions according to the three absolute deviations (global, territorial, spatial).

Usage

```
mas(x, xid, var1, var2, ref, key, order, dist, mat)
```

Arguments

x	an sf object or a SpatialPolygonsDataFrame including var1 and var2.
xid	identifier field in x (to be used for importing a personal distance matrix). Default to the first column.
var1	name of the numerator variable in x.

var2	name of the denominator variable in x.
ref	ratio of reference; if missing, the ratio of reference is the one of the whole study area ($\text{sum}(\text{var1}) / \text{sum}(\text{var2})$).
key	aggregation key field for measuring the deviation (intermediate territorial level).
order	contiguity order.
dist	distance threshold defining the contiguity. The cartesian distance between units centroids is used by default (see st_distance); use mat to apply different metrics.
mat	a distance matrix (road distance, travel time...) between x units. Row and column names must fit xid identifiers. (optional)

Value

A dataframe including the mass of numerator to redistribute to reach a perfect equilibrium according to the 3 contexts, expressed in numerator measure unit and as a share of the numerator mass.

Examples

```
data("GrandParisMetropole")
redistr <- mas(x = com, var1 = "INC", var2 = "TH", dist = 5000, key = "EPT")
redistr
```

mst *Multiscalar Typology*

Description

Compute a multiscalar typology according to the three relative deviations (general: G, territorial: T and spatial: S). The elementary units are classified in eight classes according to their three relative positions.

Usage

```
mst(x, var1, var2, ref, key, order, dist, mat, xid, threshold,
    superior = FALSE)
```

Arguments

x	a sf object or a SpatialPolygonsDataFrame including var1 and var2.
var1	name of the numerator variable in x.
var2	name of the denominator variable in x.
ref	ratio of reference; if missing, the ratio of reference is the one of the whole study area ($\text{sum}(\text{var1}) / \text{sum}(\text{var2})$).
key	aggregation key field for measuring the deviation (intermediate territorial level).
order	contiguity order.

dist	distance threshold defining the contiguity. The cartesian distance between units centroids is used by default ; use mat to apply different metrics.
mat	a distance matrix (road distance, travel time...) between x units. Row and column names must fit xid identifiers. (optional)
xid	identifier field in x (to be used for importing a personal distance matrix). Default to the first column.
threshold	defined to build the typology (100 is considered as the average).
superior	if TRUE, deviation values must be greater than threshold. If FALSE, deviation values must be lower than threshold.

Value

A dataframe including the ratio (var1/var2), the 3 relative deviations (G, T and S) and the resulting ordered typology (0 to 7).

Typology (which deviation is above/under the threshold):

- 0: none
- 1: G
- 2: T
- 3: G and T
- 4: S
- 5: G and S
- 6: T and S
- 7: G, T and S

Examples

```
# load data
data("GrandParisMetropole")
# Multiscalar typology - Wealthiest territories
row.names(com) <- com$LIBCOM
synthesis <- mst(x = com, var1 = "INC", var2 = "TH", key = "EPT",
                order = 1, threshold = 125, superior = TRUE)
# Territories avbove 125% for the 3 deviations
synthesis[synthesis$mst == 7, ]

# Multiscalar typology - Poorest territories
synthesis <- mst(x = com, var1 = "INC", var2 = "TH", key = "EPT",
                order = 1, threshold = 75, superior = FALSE)
# Territories below 75 % for the three deviations
synthesis[synthesis$mst == 7, ]
```

Description

Build multiscalar territorial analysis based on various contexts for a given ratio defined by a numerator and a denominator.

Main functions :

- **gdev**: general deviation of each territorial unit as regards to all the study area (or a reference value).
- **tdev**: territorial deviation of each territorial unit as regards to an intermediate territorial level of reference.
- **sdev**: spatial deviation of each territorial unit as regards to its geographical neighborhood.
- **mst**: multiscalar typology based on the three deviations.
- **mas**: multiscalar absolute synthesis, total amount of redistributions based on the three deviations.
- **mapmst**: multiscalar typology map.

References

GRASLAND C., YSEBAERT R., ZANIN C., LAMBERT N., Spatial disparities in Europe (Chapter 4) in GLOERSEN E., DUBOIS A. (coord.), 2007, Regional disparities and cohesion: What Strategies for the future?, DG-IPOL – European Parliament.

Description

Compute the deviation of each territorial unit as regards to its geographical neighborhood. Neighborhood is defined either by contiguity order, by a distance value or by a personal matrix (travel time...)

Usage

```
sdev(x, var1, var2, type = "rel", xid, order, dist, mat)
```

Arguments

x	an sf object or a SpatialPolygonsDataFrame including var1 and var2.
var1	name of the numerator variable in x.
var2	name of the denominator variable in x.
type	type of deviation; "rel" for relative deviation, "abs" for absolute deviation (see Details).
xid	identifier field in x (to be used for importing a personal distance matrix). Default to the first column of x. (optional)
order	contiguity order.
dist	distance threshold defining the contiguity. The cartesian distance between units centroids is used by default; use mat to apply different metrics.
mat	a distance matrix (road distance, travel time...) between x units. Row and column names must fit xid identifiers. (optional)

Details

The relative spatial deviation is the ratio between var1/var2 and var1/var2 in the specified neighborhood. Values greater than 100 indicate that the unit ratio is greater than the ratio in its neighborhood. Values lower than 100 indicate that the unit ratio is lower than the ratio in its neighborhood.

The absolute spatial deviation is the amount of numerator that could be moved to obtain the same ratio in all units of its neighborhood.

Value

A vector is returned.

Examples

```
library(sf)
library(cartography)
# load data
data("GrandParisMetropole")

# compute absolute spatial deviation in a neighborhood defined by a contiguity
# order of 2.
com$sdevabs <- sdev(x = com, var1 = "INC", var2 = "TH", order =2, type = "abs")

#compute relative spatial deviation in a neighborhood defined within a distance
# of 5km between communes' centroids
com$sdevrel <- sdev(x = com, var1 = "INC", var2 = "TH", type = "rel", dist = 5000)

# compute absolute spatial deviation in a neighborhood defined within a road
# travel time of 10 minutes by car
com$scardevabs <- sdev(x = com, var1 = "INC", var2 = "TH", type = "abs", dist = 10, mat = cardist)

# compute relative spatial deviation in a neighborhood defined within a road
# travel time of 10 minutes by car
com$scardevrel <- sdev(x = com, var1 = "INC", var2 = "TH", type = "rel", dist = 10, mat = cardist)
```

```

# map deviations
# set graphical parameters
par(mar = c(0,0,1.2,0))
# set breaks
bks <- c(min(com$scardevrel),75,100,125,150,max(com$scardevrel))
# set colot palette
cols <- carto.pal(pal1 = "blue.pal", n1 = 2,
                  pal2 = "wine.pal", n2 = 3)
# plot a choropleth map of the relative spatial deviation
choroLayer(x = com, var = "scardevrel",
           legend.pos = "topleft",
           legend.title.txt = "Relative Deviation\n(100 = spatial average)",
           breaks = bks, border = NA,
           col = cols)
# add symbols proportional to the absolute spatial deviation
com$sign <- ifelse(test = com$scardevabs<0, yes = "negative", no = "positive")
propSymbolsTypoLayer(x = com, var = "scardevabs",var2 = "sign",
                    legend.var.pos = "left",legend.values.rnd = -2,
                    legend.var2.values.order = c("positive", "negative"),
                    legend.var.title.txt = "Absolute Deviation\n(Income redistribution)",
                    col = c("#ff000050","#0000ff50"),legend.var2.pos = "n",
                    legend.var.style = "e", inches = 0.2)
# add EPT boundaries
plot(st_geometry(ept), add=TRUE)
# add a layout
layoutLayer(title = "Spatial Deviation (neighborhood : 10 minutes by car)",
           sources = "GEOFLA® 2015 v2.1, Apur, impots.gouv.fr",
           north = TRUE, scale = 5, tabtitle = TRUE, frame = FALSE, theme = "red.pal",
           author = "MTA")

```

tdev

Territorial Deviation

Description

Compute the deviation of each territorial unit as regards to an intermediate territorial level of reference.

Usage

```
tdev(x, var1, var2, type = "rel", key)
```

Arguments

x	a dataframe, an sf object or a SpatialPolygonsDataFrame including var1 and var2, and an aggregation key field (territorial belonging).
var1	name of the numerator variable in x.
var2	name of the denominator variable in x.


```
# add EPT boundaries
plot(st_geometry(ept), add=TRUE)
# add a layout
layoutLayer(title = "Territorial Deviation (reference : EPT)",
            sources = "GEOFLA® 2015 v2.1, Apur, impots.gouv.fr",
            north = TRUE, scale = 5, tabtitle = TRUE, frame = FALSE, theme = "red.pal",
            author = "MTA")
```

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