

Package ‘od’

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Title Manipulate and Map Origin-Destination Data

Version 0.2.0

Description The aim of 'od' is to provide tools and example datasets for working with origin-destination ('OD') datasets of the type used to describe aggregate urban mobility patterns (Carey et al. 1981) <doi:10.1287/trsc.15.1.32>. The package builds on functions for working with 'OD' data in the package 'stplanr', (Lovelace and Ellison 2018) <doi:10.32614/RJ-2018-053> with a focus on computational efficiency and support for the 'sf' class system (Pebesma 2018) <doi:10.32614/RJ-2018-009>. With few dependencies and a simple class system based on data frames, the package is intended to facilitate efficient analysis of 'OD' datasets and to provide a place for developing new functions. The package enables the creation and analysis of geographic entities representing large scale mobility patterns, from daily travel between zones in cities to migration between countries.

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URL <https://github.com/itsleeds/od>, <https://itsleeds.github.io/od/>

BugReports <https://github.com/itsleeds/od/issues>

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coords_to_od

Convert coordinates into a data frame of origins and destinations

Description

Takes geographic coordinates and converts them into a data frame representing the potential flows, or 'spatial interaction', between every combination of points.

Usage

```
coords_to_od(p, interzone_only = FALSE, ids_only = FALSE)
```

Arguments

<code>p</code>	A spatial points object or a matrix of coordinates representing points
<code>interzone_only</code>	Should the result only include interzonal OD pairs, in which the ID of the origin is different from the ID of the destination zone? FALSE by default
<code>ids_only</code>	Should a data frame with only 2 columns (origin and destination IDs) be returned? The default is FALSE, meaning the result should also contain the coordinates of the start and end points of each OD pair.

Value

A data frame object with O and D codes and origin and destination coordinates.

Examples

```
p = sf::st_coordinates(od_data_centroids[1:3, ])
od = points_to_od(p)
(od = coords_to_od(p, interzone_only = TRUE))
l = odc_to_sf(od[3:6], d = od[1:2])
l$v = 1
(l_oneway = od_oneway(l))
plot(l_oneway)
```

odc_to_sf

Convert origin-destination coordinates into geographic desire lines

Description

Convert origin-destination coordinates into geographic desire lines

Usage

```
odc_to_sf(odc, d = NULL, crs = 4326)
```

Arguments

<code>odc</code>	A matrix containing coordinates representing line start and end points
<code>d</code>	An optional data frame to add to the geometry column
<code>crs</code>	The coordinate reference system of the output, if not known in z. 4326 by default.

Examples

```
(odc = od_coordinates(od_data_df, p = od_data_zones, sfnames = TRUE))
(l = odc_to_sf(odc))
plot(l)
lsfc = odc_to_sf(odc)
```

odc_to_sfc *Convert origin-destination coordinates into geographic desire lines*

Description

Convert origin-destination coordinates into geographic desire lines

Usage

```
odc_to_sfc(odc)
```

Arguments

odc A matrix containing coordinates representing line start and end points

Examples

```
(odc = od_coordinates(od_data_df, p = od::od_data_zones, sfnames = TRUE))
(l = odc_to_sfc(odc))
plot(l)
```

odmatrix_to_od *Convert origin-destination data from wide to long format*

Description

This function takes a matrix representing travel between origins (with origin codes in the rownames of the matrix) and destinations (with destination codes in the colnames of the matrix) and returns a data frame representing origin-destination pairs.

Usage

```
odmatrix_to_od(odmatrix)
```

Arguments

odmatrix A matrix with row and columns representing origin and destination zone codes and cells representing the flow between these zones.

Details

The function returns a data frame with rows ordered by origin and then destination zone code values and with names orig, dest and flow.

See Also

Other od: [od_id](#), [od_to_odmatrix\(\)](#)

Examples

```
x = od_data_df
x[1:3]
odmatrix = od_to_odmatrix(od_data_df)
odmatrix
odmatrix_to_od(odmatrix)
```

od_aggregate

Aggregate od pairs based on aggregating zones

Description

This function is for aggregating OD pairs. It generally decreases the number of rows in an OD dataset, while aiming to keep the amount of travel represented in the data the same.

Usage

```
od_aggregate(od, aggzones = NULL, FUN = sum)
```

```
od_group(od, aggzones = NULL, FUN = sum)
```

Arguments

od	An origin-destination data frame
aggzones	Points within the zones defining the OD data
FUN	The aggregating function to use

Details

An alias for the function is `od_group()`.

Examples

```
od_aggregated = od_data_df[1:2, ]
aggzones = od::od_data_zones_min
subzones = od_data_zones_small
plot(aggzones$geometry)
plot(subzones$geometry, add = TRUE)
od = od_disaggregate(od_aggregated, aggzones, subzones)
od_agg = od_aggregate(od, aggzones)
names(od_agg)[1:(ncol(od_agg) - 1)] = names(od_aggregated)
attr(od_aggregated, "spec") = NULL
identical(sf::st_drop_geometry(od_agg), od_aggregated)
```

od_coordinates	<i>Create matrices representing origin-destination coordinates</i>
----------------	--

Description

This function takes a wide range of input data types (spatial lines, points or text strings) and returns a data frame of coordinates representing origin (ox, oy) and destination (dx, dy) points.

Usage

```
od_coordinates(x, p = NULL, pd = NULL, silent = TRUE, sfnames = FALSE)
```

Arguments

x	A data frame in which the first two columns are codes representing points/zones of origin and destination
p	Points representing origins and destinations
pd	Points representing destinations, if different from origin points
silent	Hide messages? FALSE by default.
sfnames	Should output column names be compatible with the sf package?

Value

A data frame with origin and destination coordinates

Examples

```
x = od_data_df
p = od_data_centroids
res = od_coordinates(x, p)[1:2, ]
class(res)
res
od_coordinates(x, p, sfnames = TRUE)[1:2, ]
od_coordinates(x, p, silent = FALSE)[1:2, ]
od_coordinates(x, p)
x = od_data_df2[1:3, ]
p = od_data_centroids2
pd = od_data_destinations
od_coordinates(x, p, pd)
```

od_data_buildings *Simple buildings dataset*

Description

Building data from OSM for testing od_disaggregate.

Examples

```
nrow(od_data_buildings)
head(od_data_buildings)
plot(od_data_buildings$geometry)
plot(od_data_zones_min$geometry, lwd = 3, col = NULL, add = TRUE)
```

od_data_centroids *Datasets reporesenting zone centroids*

Description

These are provided as a geographic (sf) object and a simple data frame with longitude (X) and latitude (Y) columns.

Note

The schema data can be (re-)generated using code in the data-raw directory.

Examples

```
head(od_data_coordinates)
```

od_data_centroids2 *Output area centroids*

Description

This dataset represents geographic centroids of Output Areas in Leeds, UK.

This dataset represents geographic centroids of Output Areas in Leeds, UK.

Note

The schema data can be (re-)generated using code in the data-raw directory.

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Examples

```
head(od_data_centroids2)
head(od_data_centroids2)
```

od_data_destinations *Workplace zone (destination) centroids*

Description

This dataset represents geographic centroids of Output Areas in Leeds, UK.

Note

The schema data can be (re-)generated using code in the data-raw directory.

Examples

```
nrow(od_data_destinations)
head(od_data_destinations)
```

od_data_df *Origin-destination datasets*

Description

Datasets representing top commuter desire lines in Leeds based on the 2011 Census. The first two variables of the data frame are the zone code of origin and destination, respectively. The other columns record the number of people who travel by different modes, including all, train, bus, bicycle and by foot.

Details

od_data_df_medium is a larger dataset with the same variables, with around 10k rows.

Note

The schema data can be (re-)generated using code in the data-raw directory.

Examples

```
od_data_df
```

od_data_df2	<i>Origin-destination data with destinations in a different layer than origins</i>
-------------	--

Description

This dataset represents commuter flows between Output Areas and Workplace Zones, the most detailed open OD data in the UK. See <https://wicid.ukdataservice.ac.uk/> and the script `data-raw/od_wpz.R` in the `od` package's GitHub repo.

Details

The dataset reports (in the 3rd column) the number of people travelling between origins and destinations.

Note

The schema data can be (re-)generated using code in the `data-raw` directory.

Examples

```
head(od_data_df2)
```

od_data_network	<i>Route network data for Leeds</i>
-----------------	-------------------------------------

Description

Route network data for Leeds

Note

The schema data can be (re-)generated using code in the `data-raw` directory.

Examples

```
head(od_data_network)
```

od_data_zones	<i>Example OD data</i>
---------------	------------------------

Description

Zone datasets for packages examples

Note

The schema data can be (re-)generated using code in the data-raw directory.

od_data_zones_small	<i>Small zones dataset</i>
---------------------	----------------------------

Description

This dataset represents geographic zones of Lower Super Output Areas in Leeds, UK. They fit completely within the od_data_zones_min dataset.

Note

The schema data can be (re-)generated using code in the data-raw directory.

Examples

```
nrow(od_data_zones_small)
head(od_data_zones_small)
plot(od_data_zones_small$geometry)
plot(od_data_zones_min$geometry, lwd = 3, col = NULL, add = TRUE)
```

od_disaggregate	<i>Split-up each OD pair into multiple OD pairs based on sub-points/subzones</i>
-----------------	--

Description

This function is for splitting-up OD pairs. It increases the number of rows in an OD dataset, while aiming to keep the amount of travel represented in the data the same. To take an analogy from another package, it's roughly equivalent to `tidyr::pivot_longer()`.

Usage

```

od_disaggregate(
  od,
  z,
  subzones = NULL,
  subpoints = NULL,
  code_append = "_ag",
  population_column = 3,
  population_per_od = 5,
  keep_ids = TRUE
)

od_split(
  od,
  z,
  subzones = NULL,
  subpoints = NULL,
  code_append = "_ag",
  population_column = 3,
  population_per_od = 5,
  keep_ids = TRUE
)

```

Arguments

od	An origin-destination data frame
z	Zones representing origins and destinations
subzones	Sub-zones within the zones defining the OD data
subpoints	Points within the zones defining the OD data
code_append	The name of the column containing aggregate zone names
population_column	The column containing the total population (if it exists)
population_per_od	Minimum number to assign per OD pair
keep_ids	Should the origin and destination ids be kept? TRUE by default, meaning 2 extra columns are appended, with the names o_agg and d_agg containing IDs from the original OD data.

Details

An alias for the function is `od_split()`.

Examples

```

od = od_data_df[1:2, ]
zones = od::od_data_zones_min
subzones = od_data_zones_small

```

```

od_disag = od_disaggregate(od, zones, subzones)
ncol(od_disag) - 1 == ncol(od) # same number of columns (except disag data gained geometry)
sum(od_disag[[3]]) == sum(od[[3]])
sum(od_disag[[4]]) == sum(od[[4]])
od_sf = od_to_sf(od, zones)
plot(od_data_zones_small$geometry)
plot(od_data_zones_min$geometry, lwd = 3, col = NULL, add = TRUE)
plot(od_sf["all"], add = TRUE)
plot(od_disag["all"], add = TRUE)

# with buildings data
od_disag_buildings = od_disaggregate(od, zones, od_data_buildings)
summary(od_disag_buildings)
plot(od_disag_buildings)

```

od_filter

Filter OD datasets

Description

This function takes an OD dataset and a character vector of codes and returns an OD dataset with rows matching origin and destination zones present in the codes.

Usage

```
od_filter(x, codes, silent = FALSE)
```

Arguments

x	A data frame in which the first two columns are codes representing points/zones of origin and destination
codes	The zone codes that must be in origins and destination
silent	Hide messages? FALSE by default.

Value

A data frame

Examples

```

x = od_data_df
z = od_data_zones
codes = z[[1]]
z_in_x_o = codes %in% x[[1]]
z_in_x_d = codes %in% x[[2]]
sum(z_in_x_d)
sum(z_in_x_o)
z = z[which(z_in_x_o | z_in_x_d)[-1], ]
z[[1]]

```

```

unique(c(x[[1]], x[[2]]))
try(od_to_sf(x, z)) # fails
nrow(x)
x = od_filter(x, z[[1]])
nrow(x)
od_to_sf(x, z)

```

od_id

Combine two ID values to create a single ID number

Description

Combine two ID values to create a single ID number

Usage

```
od_id_szudzik(x, y, ordermatters = FALSE)
```

```
od_id_max_min(x, y)
```

```
od_id_character(x, y)
```

Arguments

x a vector of numeric, character, or factor values
y a vector of numeric, character, or factor values
ordermatters logical, does the order of values matter to pairing, default = FALSE

Details

In OD data it is common to have many 'oneway' flows from "A to B" and "B to A". It can be useful to group these and have a single ID that represents pairs of IDs with or without directionality, so they contain 'twoway' or bi-directional values.

od_id* functions take two vectors of equal length and return a vector of IDs, which are unique for each combination but the same for twoway flows.

- the Szudzik pairing function, on two vectors of equal length. It returns a vector of ID numbers.

This function supersedes od_id_order as it is faster on large datasets

See Also

od_oneway

Other od: [od_to_odmatrix\(\)](#), [odmatrix_to_od\(\)](#)

Examples

```
(d = od_data_df[2:9, 1:2])
(id = od_id_character(d[[1]], d[[2]]))
duplicated(id)
od_id_szudzik(d[[1]], d[[2]])
od_id_max_min(d[[1]], d[[2]])
```

od_id_order	<i>Generate ordered ids of OD pairs so lowest is always first This function is slow on large datasets, see szudzik_pairing for faster alternative</i>
-------------	---

Description

Generate ordered ids of OD pairs so lowest is always first This function is slow on large datasets, see szudzik_pairing for faster alternative

Usage

```
od_id_order(x, id1 = names(x)[1], id2 = names(x)[2])
```

Arguments

x	A data frame representing OD pairs
id1	Optional (it is assumed to be the first column) text string referring to the name of the variable containing the unique id of the origin
id2	Optional (it is assumed to be the second column) text string referring to the name of the variable containing the unique id of the destination

Examples

```
x = data.frame(id1 = c(1, 1, 2, 2, 3), id2 = c(1, 2, 3, 1, 4))
od_id_order(x) # 4th line switches id1 and id2 so oneway_key is in order
```

od_interzone	<i>Return only interzonal (io intrazonal) OD pairs</i>
--------------	--

Description

This function takes an OD dataset and returns only the rows corresponding to movements in which the origin is different than the destination.

Usage

```
od_interzone(x)

od_intrazone(x)
```

Arguments

`x` A data frame in which the first two columns are codes representing points/zones of origin and destination

Examples

```
od_data = points_to_od(od_data_centroids)
nrow(od_data)
nrow(od_interzone(od_data))
nrow(od_intrazone(od_data))
```

od_oneway	<i>Aggregate OD pairs they become non-directional</i>
-----------	---

Description

For example, sum total travel in both directions.

Usage

```
od_oneway(
  x,
  attrib = names(x[-c(1:2)])[vapply(x[-c(1:2)], is.numeric, TRUE)],
  FUN = sum,
  ...,
  id1 = names(x)[1],
  id2 = names(x)[2],
  oneway_key = NULL
)
```

Arguments

`x` A data frame or SpatialLinesDataFrame, representing an OD matrix

`attrib` A vector of column numbers or names, representing variables to be aggregated. By default, all numeric variables are selected.

`FUN` The aggregating function such as sum (the default) and mean

`...` Further arguments passed to or used by methods

`id1` Optional (it is assumed to be the first column) text string referring to the name of the variable containing the unique id of the origin

`id2` Optional (it is assumed to be the second column) text string referring to the name of the variable containing the unique id of the destination

`oneway_key` Optional key of unique OD pairs regardless of the order, e.g., as generated by [od_id_max_min\(\)](#) or [od_id_szudzik\(\)](#)

Details

Flow data often contains movement in two directions: from point A to point B and then from B to A. This can be problematic for transport planning, because the magnitude of flow along a route can be masked by flows the other direction. If only the largest flow in either direction is captured in an analysis, for example, the true extent of travel will be heavily under-estimated for OD pairs which have similar amounts of travel in both directions. Flows in both directions are often represented by overlapping lines with identical geometries which can be confusing for users and are difficult to plot.

Value

oneway outputs a data frame (or sf data frame) with rows containing results for the user-selected attribute values that have been aggregated.

Examples

```
(od_min = od_data_df[c(1, 2, 1), 1:4])
od_min[3, 1:2] = rev(od_min[3, 1:2])
od_min[3, 3:4] = od_min[3, 3:4] - 5
(od_oneway = od_oneway(od_min))
nrow(od_oneway) < nrow(od_min) # result has fewer rows
sum(od_min$all) == sum(od_oneway$all) # but the same total flow
(od_oneway = od_oneway(od_min, FUN = mean))
od_oneway(od_min, attrib = "all")
od_min$all[3] = NA
(od_oneway = od_oneway(od_min, FUN = mean, na.rm = TRUE))
```

od_to_network	<i>Convert OD data into lines with start and end points sampled on a network</i>
---------------	--

Description

Convert OD data into lines with start and end points sampled on a network

Usage

```
od_to_network(
  x,
  z,
  zd = NULL,
  silent = TRUE,
  package = "sf",
  crs = 4326,
  network = NULL
)
```


Arguments

x	A data frame in which the first two columns are codes representing points/zones of origin and destination
z	Zones representing origins and destinations
zd	Zones representing destinations
silent	Hide messages? FALSE by default.
package	Which package to use to create the sf object? sfheaders is the default.
crs	The coordinate reference system of the output, if not known in z. 4326 by default.
network	An sf object representing a transport network

Examples

```
x = od_data_df
z = od_data_zones_min
network = od_data_network
(lines_to_points_on_network = od_to_network(x, z, network = network))
(lines_to_points = od_to_sf(x, z))
```

od_to_odmatrix

Convert origin-destination data from long to wide format

Description

This function takes a data frame representing travel between origins (with origin codes in `name_orig`, typically the 1st column) and destinations (with destination codes in `name_dest`, typically the second column) and returns a matrix with cell values (from `attrib`, the third column by default) representing travel between origins and destinations.

Usage

```
od_to_odmatrix(x, attrib = 3, name_orig = 1, name_dest = 2)
```

Arguments

x	A data frame representing flows between origin and destinations
attrib	A number or character string representing the column containing the attribute data of interest from the flow data frame
name_orig	A number or character string representing the zone of origin
name_dest	A number or character string representing the zone of destination

See Also

Other od: [od_id](#), [odmatrix_to_od\(\)](#)

Examples

```
x = od_data_df[1:4, ]
x_matrix = od_to_odmatrix(x)
class(x_matrix)
od_to_odmatrix(x, attrib = "bicycle")
```

od_to_sf

Convert OD data into geographic 'desire line' objects

Description

Convert OD data into geographic 'desire line' objects

Usage

```
od_to_sf(
  x,
  z,
  zd = NULL,
  odc = NULL,
  silent = FALSE,
  filter = TRUE,
  package = "sfheaders",
  crs = 4326
)
```

```
od_to_sf(
  x,
  z,
  zd = NULL,
  silent = TRUE,
  package = "sfheaders",
  crs = 4326,
  filter = TRUE
)
```

Arguments

x	A data frame in which the first two columns are codes representing points/zones of origin and destination
z	Zones representing origins and destinations
zd	Zones representing destinations
odc	A matrix containing coordinates representing line start and end points
silent	Hide messages? FALSE by default.
filter	Remove rows with no matches in z? TRUE by default

package	Which package to use to create the sf object? sfheaders is the default.
crs	The coordinate reference system of the output, if not known in z. 4326 by default.

Examples

```
x = od_data_df
z = od_data_zones
desire_lines = od_to_sf(x, z)
desire_lines[1:3]
plot(desire_lines)
desire_lines_d = od_to_sf(od_data_df2, od_data_centroids2, od_data_destinations)
o1 = od_data_centroids2[od_data_centroids2[[1]] == od_data_df2[[1]][1], ]
d1 = od_data_destinations[od_data_destinations[[1]] == od_data_df2[[2]][1], ]
plot(desire_lines_d$geometry)
plot(o1, add = TRUE)
plot(d1, add = TRUE)
plot(desire_lines_d$geometry[1], lwd = 3, add = TRUE)
n = 7
on = od_data_centroids2[od_data_centroids2[[1]] == od_data_df2[[1]][n], ]
dn = od_data_destinations[od_data_destinations[[1]] == od_data_df2[[2]][n], ]
plot(desire_lines_d$geometry)
plot(on, add = TRUE)
plot(dn, add = TRUE)
plot(desire_lines_d$geometry[n], lwd = 3, add = TRUE)
```

points_to_od	<i>Convert a series of points into a dataframe of origins and destinations</i>
--------------	--

Description

Takes a series of geographical points and converts them into a data.frame representing the potential flows, or 'spatial interaction', between every combination of points.

Usage

```
points_to_od(p, interzone_only = FALSE, ids_only = FALSE)
```

```
points_to_odl(p, interzone_only = FALSE, ids_only = FALSE, crs = 4326)
```

Arguments

p	A spatial points object or a matrix of coordinates representing points
interzone_only	Should the result only include interzonal OD pairs, in which the ID of the origin is different from the ID of the destination zone? FALSE by default
ids_only	Should a data frame with only 2 columns (origin and destination IDs) be returned? The default is FALSE, meaning the result should also contain the coordinates of the start and end points of each OD pair.
crs	The coordinate reference system of the output, if not known in z. 4326 by default.

Details

`points_to_odl()` generates the same output but returns a geographic object representing desire lines in the class `sf`.

Examples

```
library(sf)
p = od_data_centroids[1:3, ]
points_to_od(p)
points_to_od(p, ids_only = TRUE)
(l = points_to_odl(p, interzone_only = TRUE))
plot(l)
(od = points_to_od(p, interzone_only = TRUE))
l2 = od_to_sf(od, od_data_centroids)
l2$v = 1
(l2_oneway = od_oneway(l2))
plot(l2)
```

`sfc_point_to_matrix` *Extract coordinates from sfc objects with point geometry*

Description

This function takes point geometries with class `sfc` from the `sf` package and returns a matrix representing x and y (typically lon/lat) coordinates.

Usage

```
sfc_point_to_matrix(x)
```

Arguments

`x` An `sfc` object

Details

See <https://github.com/dcooley/sfheaders/issues/52> for details

Author(s)

Dave Cooley

Examples

```
sfc_point_to_matrix(od_data_centroids$geometry[1:6])
```

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