Package: spatsoc (via r-universe)

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Title Group Animal Relocation Data by Spatial and Temporal Relationship

Version 0.2.6

Description Detects spatial and temporal groups in GPS relocations (Robitaille et al. (2019) <doi:10.1111/2041-210X.13215>). It can be used to convert GPS relocations to gambit-of-the-group format to build proximity-based social networks In addition, the randomizations function provides data-stream randomization methods suitable for GPS data.

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URL https://docs.ropensci.org/spatsoc/, https://github.com/ropensci/spatsoc

BugReports https://github.com/ropensci/spatsoc/issues

Depends R (>= 3.4)

Imports adehabitatHR (>= 0.4.21), data.table (>= 1.10.5), igraph, sf, lwgeom, CircStats, stats, units

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Repository https://ropensci.r-universe.dev

RemoteUrl https://github.com/ropensci/spatsoc

RemoteRef main

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Contents

`build_lines` *Build Lines*

Description

`build_lines` generates a simple feature collection with LINESTRINGs from a `data.table`. The function expects a `data.table` with relocation data, individual identifiers, a sorting column and a `projection`. The relocation data is transformed into LINESTRINGs for each individual and, optionally, combination of columns listed in `splitBy`. Relocation data should be in two columns representing the X and Y coordinates.

Usage

```
build_lines(
  DT = NULL,
  projection = NULL,
  id = NULL,
  coords = NULL,
  sortBy = NULL,
  splitBy = NULL
)
```

Arguments

DT	input data.table
projection	numeric or character defining the coordinate reference system to be passed to sf::st_crs. For example, either projection = "EPSG:32736" or projection = 32736.
id	Character string of ID column name
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
sortBy	Character string of date time column(s) to sort rows by. Must be a POSIXct.
splitBy	(optional) character string or vector of grouping column name(s) upon which the grouping will be calculated

Details

R-spatial evolution:

Please note, spatsoc has followed updates from R spatial, GDAL and PROJ for handling projections, see more at https://r-spatial.org/r/2020/03/17/wkt.html.

In addition, build_lines previously used sp::SpatialLines but has been updated to use sf::st_as_sf and sf::st_linestring according to the R-spatial evolution, see more at https://r-spatial.org/r/2022/04/12/evolution.html.

Notes on arguments:

The projection argument expects a numeric or character defining the coordinate reference system. For example, for UTM zone 36N (EPSG 32736), the projection argument is either projection = 'EPSG:32736' or projection = 32736. See details in sf::st_crs() and https://spatialreference.org for a list of EPSG codes.

The sortBy argument is used to order the input DT when creating sf LINESTRINGs. It must a column in the input DT of type POSIXct to ensure the rows are sorted by date time.

The splitBy argument offers further control building LINESTRINGs. If in your input DT, you have multiple temporal groups (e.g.: years) for example, you can provide the name of the column which identifies them and build LINESTRINGs for each individual in each year.

build_lines is used by group_lines for grouping overlapping lines generated from relocations.

Value

build_lines returns an sf LINESTRING object with a line for each individual (and optionally splitBy combination).

Individuals (or combinations of individuals and splitBy) with less than two relocations are dropped since it requires at least two relocations to build a line.

See Also

group_lines

Other Build functions: build_polys()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# EPSG code for example data
utm <- 32736

# Build lines for each individual
lines <- build_lines(DT, projection = utm, id = 'ID', coords = c('X', 'Y'),
            sortBy = 'datetime')

# Build lines for each individual by year
DT[, yr := year(datetime)]
lines <- build_lines(DT, projection = utm, id = 'ID', coords = c('X', 'Y'),
            sortBy = 'datetime', splitBy = 'yr')
```

`build_polys` *Build Polygons*

Description

`build_polys` generates a simple feature collection with POLYGONs from a `data.table`. The function expects a `data.table` with relocation data, individual identifiers, a projection, home range type and parameters. The relocation data is transformed into POLYGONs using either adehabitatHR::mcp or adehabitatHR::kernelUD for each individual and, optionally, combination of columns listed in `splitBy`. Relocation data should be in two columns representing the X and Y coordinates.

Usage

```
build_polys(
  DT = NULL,
  projection = NULL,
  hrType = NULL,
  hrParams = NULL,
  id = NULL,
  coords = NULL,
  splitBy = NULL,
  spPts = NULL
)
```

Arguments

DT	input data.table
projection	numeric or character defining the coordinate reference system to be passed to sf::st_crs. For example, either projection = "EPSG:32736" or projection = 32736.
hrType	type of HR estimation, either 'mcp' or 'kernel'
hrParams	a named list of parameters for adehabitatHR functions
id	Character string of ID column name
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
splitBy	(optional) character string or vector of grouping column name(s) upon which the grouping will be calculated
spPts	alternatively, provide solely a SpatialPointsDataFrame with one column representing the ID of each point, as specified by adehabitatHR::mcp or adehabitatHR::kernelUD

Details

group_polys uses build_polys for grouping overlapping polygons created from relocations.

R-spatial evolution:

Please note, spatsoc has followed updates from R spatial, GDAL and PROJ for handling projections, see more below and details at https://r-spatial.org/r/2020/03/17/wkt.html.

In addition, build_polys previously used sp::SpatialPoints but has been updated to use sf::st_as_sf according to the R-spatial evolution, see more at https://r-spatial.org/r/2022/04/12/evolution.html.

Notes on arguments:

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT.

The id, coords (and optional splitBy) arguments expect the names of respective columns in DT which correspond to the individual identifier, X and Y coordinates, and additional grouping columns.

The projection argument expects a character string or numeric defining the coordinate reference system to be passed to sf::st_crs. For example, for UTM zone 36S (EPSG 32736), the projection argument is projection = "EPSG:32736" or projection = 32736. See https://spatialreference.org for a list of EPSG codes.

The hrType must be either one of "kernel" or "mcp". The hrParams must be a named list of arguments matching those of adehabitatHR::kernelUD and adehabitatHR::getverticeshr or adehabitatHR::mcp.

The splitBy argument offers further control building POLYGONs. If in your DT, you have multiple temporal groups (e.g.: years) for example, you can provide the name of the column which identifies them and build POLYGONs for each individual in each year.

Value

build_polys returns a simple feature collection with POLYGONs for each individual (and optionally splitBy combination).

An error is returned when hrParams do not match the arguments of the respective hrType adehabitatHR function.

See Also

group_polys

Other Build functions: build_lines()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# EPSG code for example data
utm <- 32736

# Build polygons for each individual using kernelUD and getverticeshr
build_polys(DT, projection = utm, hrType = 'kernel',
            hrParams = list(grid = 60, percent = 95),
            id = 'ID', coords = c('X', 'Y'))

# Build polygons for each individual by year
DT[, yr := year(datetime)]
build_polys(DT, projection = utm, hrType = 'mcp',
            hrParams = list(percent = 95),
            id = 'ID', coords = c('X', 'Y'), splitBy = 'yr')
```

---

centroid_dyad *Dyad centroid*

Description

centroid_dyad calculates the centroid (mean location) of a dyad in each observation identified by edge_nn or edge_dist. The function accepts an edge list generated by edge_nn or edge_dist and a data.table with relocation data appended with a timegroup column from group_times. It is recommended to use the argument fillNA = FALSE for edge_dist when using centroid_dyad to avoid unnecessarily merging additional rows. Relocation data should be in two columns representing the X and Y coordinates.

Usage

```
centroid_dyad(
  edges = NULL,
  DT = NULL,
  id = NULL,
  coords = NULL,
  timegroup = "timegroup",
  na.rm = FALSE
)
```

Arguments

edges	edge list generated generated by edge_dist or edge_nn, with dyad ID column generated by dyad_id
DT	input data.table with timegroup column generated with group_times matching the input data.table used to generate the edge list with edge_nn or edge_dist
id	Character string of ID column name
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
timegroup	timegroup field in the DT within which the grouping will be calculated
na.rm	if NAs should be removed in calculating mean location, see rowMeans

Details

The edges and DT must be data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT or by reassigning using data.table::data.table.

The edges and DT are internally merged in this function using the columns id, dyadID and timegroup. This function expects a dyadID present, generated with the dyad_id function. The dyadID and timegroup arguments expect the names of a column in edges which correspond to the dyadID and timegroup columns. The id and timegroup arguments expect the names of a column in DT which correspond to the X and Y coordinates and group columns. The na.rm argument is passed to the rowMeans function to control if NA values are removed before calculation.

Value

centroid_dyad returns the input edges appended with centroid columns for the X and Y coordinate columns.

These columns represents the centroid coordinate columns for the dyad. The naming of these columns will correspond to the provided coordinate column names prefixed with "centroid_".

Note: due to the merge required within this function, the output needs to be reassigned unlike some other spatsoc functions like dyad_id and group_pts.

A message is returned when centroid columns are already exists in the input edges, because they will be overwritten.

See Also

dyad_id edge_dist edge_nn group_pts

Other Centroid functions: `centroid_fusion()`, `centroid_group()`

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')

# Edge list generation
edges <- edge_dist(
    DT,
    threshold = 100,
    id = 'ID',
    coords = c('X', 'Y'),
    timegroup = 'timegroup',
    returnDist = TRUE,
    fillNA = FALSE
  )

# Generate dyad id
dyad_id(edges, id1 = 'ID1', id2 = 'ID2')

# Calculate dyad centroid
centroids <- centroid_dyad(
  edges,
  DT,
  id = 'ID',
  coords = c('X', 'Y'),
  timegroup = 'timegroup', na.rm = TRUE
)

print(centroids)
```

`centroid_fusion` *Fusion centroid*

Description

centroid_fusion calculates the centroid (mean location) of each timestep in fusion events. The function accepts an edge list of fusion events identified by fusion_id from edge lists generated with edge_dist and a data.table with relocation data appended with a timegroup column from group_times. It is recommended to use the argument fillNA = FALSE for edge_dist when using centroid_fusion to avoid unnecessarily merging additional rows. Relocation data should be in two columns representing the X and Y coordinates.

Usage

```
centroid_fusion(
  edges = NULL,
  DT = NULL,
  id = NULL,
  coords = NULL,
  timegroup = "timegroup",
  na.rm = FALSE
)
```

Arguments

edges	edge list generated generated by edge_dist or edge_nn, with fusionID column generated by fusion_id
DT	input data.table with timegroup column generated with group_times matching the input data.table used to generate the edge list with edge_nn or edge_dist
id	Character string of ID column name
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
timegroup	timegroup field in the DT within which the grouping will be calculated
na.rm	if NAs should be removed in calculating mean location, see rowMeans

Details

The edges and DT must be data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT or by reassigning using data.table::data.table.

The edges and DT are internally merged in this function using the columns timegroup (from group_times) and ID1 and ID2 (in edges, from dyad_id) and id (in DT). This function expects a fusionID present, generated with the fusion_id function. The timegroup argument expects the names of a column in edges which correspond to the timegroup column. The id, coords and timegroup arguments expect the names of a column in DT which correspond to the id, X and Y coordinates and timegroup columns. The na.rm argument is passed to the rowMeans function to control if NA values are removed before calculation.

Value

centroid_fusion returns the input edges appended with centroid columns for the X and Y coordinate columns.

These columns represents the centroid coordinate columns for each timestep in a fusion event. The naming of these columns will correspond to the provided coordinate column names prefixed with "centroid_".

Note: due to the merge required within this function, the output needs to be reassigned unlike some other `spatsoc` functions like `fusion_id` and `group_pts`.

A message is returned when centroid columns are already exists in the input `edges`, because they will be overwritten.

See Also

fusion_id edge_dist group_pts

Other Centroid functions: `centroid_dyad()`, `centroid_group()`

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')

# Edge list generation
edges <- edge_dist(
    DT,
    threshold = 100,
    id = 'ID',
    coords = c('X', 'Y'),
    timegroup = 'timegroup',
    returnDist = TRUE,
    fillNA = FALSE
  )

# Generate dyad id
dyad_id(edges, id1 = 'ID1', id2 = 'ID2')

# Generate fusion id
fusion_id(edges, threshold = 100)

# Calculate fusion centroid
centroids <- centroid_fusion(
  edges,
  DT,
  id = 'ID',
  coords = c('X', 'Y'),
```

```
  timegroup = 'timegroup', na.rm = TRUE
)

print(centroids)
```

`centroid_group` *Group centroid*

Description

`centroid_group` calculates the centroid (mean location) of all individuals in each spatiotemporal group identified by `group_pts`. The function accepts a `data.table` with relocation data appended with a `group` column from `group_pts`. Relocation data should be in two columns representing the X and Y coordinates.

Usage

```
centroid_group(DT = NULL, coords = NULL, group = "group", na.rm = FALSE)
```

Arguments

`DT`	input data.table with group column generated with `group_pts`
`coords`	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
`group`	Character string of group column
`na.rm`	if NAs should be removed in calculating mean location, see `mean`

Details

The `DT` must be a `data.table`. If your data is a `data.frame`, you can convert it by reference using `data.table::setDT` or by reassigning using `data.table::data.table`.

The `coords` and `group` arguments expect the names of a column in `DT` which correspond to the X and Y coordinates and group columns. The `na.rm` argument is passed to the `mean` function to control if NA values are removed before calculation.

Value

`centroid_group` returns the input `DT` appended with centroid columns for the X and Y coordinate columns.

These columns represents the centroid coordinate columns. The naming of these columns will correspond to the provided coordinate column names prefixed with "centroid_".

A message is returned when centroid columns are already exists in the input `DT`, because they will be overwritten.

See Also

group_pts

Other Centroid functions: centroid_dyad(), centroid_fusion()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')

# Spatial grouping with timegroup
group_pts(DT, threshold = 5, id = 'ID',
          coords = c('X', 'Y'), timegroup = 'timegroup')

# Calculate group centroid
centroid_group(DT, coords = c('X', 'Y'), group = 'group', na.rm = TRUE)
```

---

direction_group *Group mean direction*

Description

direction_group calculates the mean direction of all individuals in each spatiotemporal group identified by group_pts. The function accepts a data.table with relocation data appended with a direction column from direction_step and a group column from group_pts.

Usage

```
direction_group(DT, direction = "direction", group = "group")
```

Arguments

DT	input data.table with distance column generated by distance_step and group column generated with group_pts
direction	character string of direction column name, default "direction"
group	character string of group column name, default "group"

Details

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT or by reassigning using data.table::data.table.

The direction and group arguments expect the names of columns in DT which correspond to the direction and group columns. The direction column is expected in units of radians and the mean calculated with CircStats::circ.mean().

Value

direction_group returns the input DT appended with a group_direction column representing the mean direction of all individuals in each spatiotemporal group.

The mean direction is calculated using CircStats::circ.mean() which expects units of radians.

A message is returned when the group_direction columns already exists in the input DT, because it will be overwritten.

References

See example of using mean group direction:

- https://doi.org/10.1098/rsos.170148
- https://doi.org/10.1098/rsos.201128
- https://doi.org/10.1016/j.beproc.2018.01.013

See Also

direction_step, group_pts, CircStats::circ.mean()

Other Direction functions: direction_polarization(), direction_step()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')

# Spatial grouping with timegroup
group_pts(DT, threshold = 50, id = 'ID',
          coords = c('X', 'Y'), timegroup = 'timegroup')

# Calculate direction at each step
direction_step(
```

```
  DT = DT,
  id = 'ID',
  coords = c('X', 'Y'),
  projection = 32736
)

# Calculate group direction
direction_group(DT)
```

`direction_polarization` *Polarization*

Description

`direction_polarization` calculates the polarization of individual directions in each spatiotemporal group identified by `group_pts`. The function expects a `data.table` with relocation data appended with a `direction` column from `direction_step` and a `group` column from `group_pts`.

Usage

```
direction_polarization(DT, direction = "direction", group = "group")
```

Arguments

`DT`	input data.table with distance column generated by `distance_step` and group column generated with `group_pts`
`direction`	character string of direction column name, default "direction"
`group`	character string of group column name, default "group"

Details

The `DT` must be a `data.table`. If your data is a `data.frame`, you can convert it by reference using `data.table::setDT` or by reassigning using `data.table::data.table`.

The `direction` and `group` arguments expect the names of columns in `DT` which correspond to the direction and group columns. The direction column is expected in units of radians and the polarization is calculated with `CircStats::r.test()`.

Value

`direction_polarization` returns the input `DT` appended with a `polarization` column representing the direction polarization of all individuals in each spatiotemporal group.

The direction polarization is calculated using `CircStats::r.test()` which expects units of radians.

A message is returned when the `polarization` columns already exists in the input `DT`, because it will be overwritten.

References

See example of using polarization:

- https://doi.org/10.1016/j.cub.2017.08.004
- <10.1371/journal.pcbi.1009437>
- https://doi.org/10.7554/eLife.19505

See Also

direction_step, group_pts, CircStats::r.test()

Other Direction functions: direction_group(), direction_step()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')

# Spatial grouping with timegroup
group_pts(DT, threshold = 50, id = 'ID',
          coords = c('X', 'Y'), timegroup = 'timegroup')

# Calculate direction at each step
direction_step(
  DT = DT,
  id = 'ID',
  coords = c('X', 'Y'),
  projection = 32736
)

# Calculate polarization
direction_polarization(DT)
```

---

direction_step *Calculate direction at each step*

Description

direction_step calculates the direction of movement steps in radians. The function accepts a data.table with relocation data and individual identifiers. Relocation data should be in two columns representing the X and Y coordinates. Note the order of rows is not modified by this function and therefore users must be cautious to set it explicitly. See example for one approach to setting order of rows using a datetime field.

Usage

```
direction_step(
  DT = NULL,
  id = NULL,
  coords = NULL,
  projection = NULL,
  splitBy = NULL
)
```

Arguments

DT	input data.table
id	Character string of ID column name
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
projection	numeric or character defining the coordinate reference system to be passed to sf::st_crs. For example, either projection = "EPSG:32736" or projection = 32736.
splitBy	(optional) character string or vector of grouping column name(s) upon which the grouping will be calculated

Details

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT or by reassigning using data.table::data.table.

The id, coords, and optional splitBy arguments expect the names of a column in DT which correspond to the individual identifier, X and Y coordinates, and additional grouping columns.

The projection argument expects a character string or numeric defining the coordinate reference system to be passed to sf::st_crs. For example, for UTM zone 36S (EPSG 32736), the projection argument is projection = "EPSG:32736" or projection = 32736. See https://spatialreference.org for #' a list of EPSG codes.

The splitBy argument offers further control over grouping. If within your DT, you have distinct sampling periods for each individual, you can provide the column name(s) which identify them to splitBy. The direction calculation by direction_step will only consider rows within each id and splitBy subgroup.

Value

direction_step returns the input DT appended with a direction column with units set to radians using the units package.

This column represents the azimuth between the sequence of points for each individual computed using lwgeom::st_geod_azimuth. Note, the order of points is not modified by this function and therefore it is crucial the user sets the order of rows to their specific question before using direction_step. In addition, the direction column will include an NA value for the last point in each sequence of points since there is no future point to calculate a direction to.

A message is returned when a direction column are already exists in the input DT, because it will be overwritten.

See Also

amt::direction_abs(), geosphere::bearing()

Other Direction functions: direction_group(), direction_polarization()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# Set order using data.table::setorder
setorder(DT, datetime)

# Calculate direction
direction_step(
  DT = DT,
  id = 'ID',
  coords = c('X', 'Y'),
  projection = 32736
)
```

---

direction_to_centroid *Direction to group centroid*

Description

direction_to_centroid calculates the direction of each relocation to the centroid of the spatiotemporal group identified by group_pts. The function accepts a data.table with relocation data appended with a group column from group_pts and centroid columns from centroid_group. Relocation data should be in planar coordinates provided in two columns representing the X and Y coordinates.

Usage

```
direction_to_centroid(DT = NULL, coords = NULL)
```

Arguments

DT	input data.table
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.

Details

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT or by reassigning using data.table::data.table.

This function expects a group column present generated with the group_pts function and centroid coordinate columns generated with the centroid_group function. The coords and group arguments expect the names of columns in DT which correspond to the X and Y coordinates and group columns.

Value

direction_to_centroid returns the input DT appended with a direction_centroid column indicating the direction to group centroid in radians. The direction is measured in radians in the range of 0 to 2 * pi from the positive x-axis.

A message is returned when direction_centroid column already exist in the input DT, because they will be overwritten.

References

See example of using direction to group centroid:

- https://doi.org/10.1016/j.cub.2017.08.004

See Also

centroid_group, group_pts

Other Distance functions: distance_to_centroid()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]
```

```
# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')

# Spatial grouping with timegroup
group_pts(DT, threshold = 5, id = 'ID',
          coords = c('X', 'Y'), timegroup = 'timegroup')

# Calculate group centroid
centroid_group(DT, coords = c('X', 'Y'), group = 'group', na.rm = TRUE)

# Calculate direction to group centroid
direction_to_centroid(DT, coords = c('X', 'Y'))
```

`distance_to_centroid` *Distance to group centroid*

Description

`distance_to_centroid` calculates the distance of each relocation to the centroid of the spatiotemporal group identified by `group_pts`. The function accepts a `data.table` with relocation data appended with a `group` column from `group_pts` and centroid columns from `centroid_group`. Relocation data should be in planar coordinates provided in two columns representing the X and Y coordinates.

Usage

```
distance_to_centroid(
  DT = NULL,
  coords = NULL,
  group = "group",
  return_rank = FALSE,
  ties.method = NULL
)
```

Arguments

`DT`	input data.table
`coords`	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
`group`	group column name, generated by `group_pts`, default 'group'
`return_rank`	boolean if rank distance should also be returned, default FALSE
`ties.method`	see `?data.table::frank`

Details

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT or by reassigning using data.table::data.table.

This function expects a group column present generated with the group_pts function and centroid coordinate columns generated with the centroid_group function. The coords and group arguments expect the names of columns in DT which correspond to the X and Y coordinates and group columns. The return_rank argument controls if the rank of each individual's distance to the group centroid is also returned. The ties.method argument is passed to data.table::frank, see details at ?data.table::frank.

Value

distance_to_centroid returns the input DT appended with a distance_centroid column indicating the distance to group centroid and, optionally, a rank_distance_centroid column indicating the within group rank distance to group centroid (if return_rank = TRUE).

A message is returned when distance_centroid and optional rank_distance_centroid columns already exist in the input DT, because they will be overwritten.

References

See examples of using distance to group centroid:

- https://doi.org/10.1016/j.anbehav.2021.08.004
- https://doi.org/10.1111/eth.12336
- https://doi.org/10.1007/s13364-018-0400-2

See Also

centroid_group, group_pts

Other Distance functions: direction_to_centroid()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')

# Spatial grouping with timegroup
group_pts(DT, threshold = 5, id = 'ID',
          coords = c('X', 'Y'), timegroup = 'timegroup')
```

```
# Calculate group centroid
centroid_group(DT, coords = c('X', 'Y'), group = 'group', na.rm = TRUE)

# Calculate distance to group centroid
distance_to_centroid(
  DT,
  coords = c('X', 'Y'),
  group = 'group',
  return_rank = TRUE
)
```

DT *Movement of 10 "Newfoundland Bog Cows"*

Description

A dataset containing the GPS relocations of 10 individuals in winter 2016-2017.

Format

A data.table with 14297 rows and 5 variables:

ID individual identifier

X X coordinate of the relocation (UTM 36N)

Y Y coordinate of the relocation (UTM 36N)

datetime character string representing the date time

population sub population within the individuals

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))
```

dyad_id *Dyad ID*

Description

Generate a dyad ID for edge list generated by edge_nn or edge_dist.

Usage

```
dyad_id(DT = NULL, id1 = NULL, id2 = NULL)
```

Arguments

DT	input data.table with columns id1 and id2, as generated by edge_dist or edge_nn
id1	ID1 column name generated by edge_dist or edge_nn
id2	ID2 column name generated by edge_dist or edge_nn

Details

An undirected edge identifier between, for example individuals A and B will be A-B (and reverse B and A will be A-B). Internally sorts and pastes id columns.

More details in the edge and dyad vignette (in progress).

Value

dyad_id returns the input data.table with appended "dyadID" column

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')

# Edge list generation
edges <- edge_dist(
    DT,
    threshold = 100,
    id = 'ID',
    coords = c('X', 'Y'),
```

```
    timegroup = 'timegroup',
    returnDist = TRUE,
    fillNA = TRUE
  )

# Generate dyad IDs
dyad_id(edges, 'ID1', 'ID2')
```

---

edge_dist *Distance based edge lists*

Description

edge_dist returns edge lists defined by a spatial distance within the user defined threshold. The function expects a data.table with relocation data, individual identifiers and a threshold argument. The threshold argument is used to specify the criteria for distance between points which defines a group. Relocation data should be in two columns representing the X and Y coordinates.

Usage

```
edge_dist(
  DT = NULL,
  threshold,
  id = NULL,
  coords = NULL,
  timegroup,
  splitBy = NULL,
  returnDist = FALSE,
  fillNA = TRUE
)
```

Arguments

DT	input data.table
threshold	distance for grouping points, in the units of the coordinates
id	Character string of ID column name
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
timegroup	timegroup field in the DT within which the grouping will be calculated
splitBy	(optional) character string or vector of grouping column name(s) upon which the grouping will be calculated
returnDist	boolean indicating if the distance between individuals should be returned. If FALSE (default), only ID1, ID2 columns (and timegroup, splitBy columns if provided) are returned. If TRUE, another column "distance" is returned indicating the distance between ID1 and ID2.
fillNA	boolean indicating if NAs should be returned for individuals that were not within the threshold distance of any other. If TRUE, NAs are returned. If FALSE, only edges between individuals within the threshold distance are returned.

Details

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT.

The id, coords timegroup (and optional splitBy) arguments expect the names of a column in DT which correspond to the individual identifier, X and Y coordinates, timegroup (generated by group_times) and additional grouping columns.

If provided, the threshold must be provided in the units of the coordinates and must be larger than 0. If the threshold is NULL, the distance to all other individuals will be returned. The coordinates must be planar coordinates (e.g.: UTM). In the case of UTM, a threshold = 50 would indicate a 50m distance threshold.

The timegroup argument is required to define the temporal groups within which edges are calculated. The intended framework is to group rows temporally with group_times then spatially with edge_dist. If you have already calculated temporal groups without group_times, you can pass this column to the timegroup argument. Note that the expectation is that each individual will be observed only once per timegroup. Caution that accidentally including huge numbers of rows within timegroups can overload your machine since all pairwise distances are calculated within each timegroup.

The splitBy argument offers further control over grouping. If within your DT, you have multiple populations, subgroups or other distinct parts, you can provide the name of the column which identifies them to splitBy. edge_dist will only consider rows within each splitBy subgroup.

Value

edge_dist returns a data.table with columns ID1, ID2, timegroup (if supplied) and any columns provided in splitBy. If 'returnDist' is TRUE, column 'distance' is returned indicating the distance between ID1 and ID2.

The ID1 and ID2 columns represent the edges defined by the spatial (and temporal with group_times) thresholds.

See Also

Other Edge-list generation: edge_nn()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')
```

```
# Edge list generation
edges <- edge_dist(
    DT,
    threshold = 100,
    id = 'ID',
    coords = c('X', 'Y'),
    timegroup = 'timegroup',
    returnDist = TRUE,
    fillNA = TRUE
  )
```

---

edge_nn *Nearest neighbour based edge lists*

Description

edge_nn returns edge lists defined by the nearest neighbour. The function expects a data.table with relocation data, individual identifiers and a threshold argument. The threshold argument is used to specify the criteria for distance between points which defines a group. Relocation data should be in two columns representing the X and Y coordinates.

Usage

```
edge_nn(
  DT = NULL,
  id = NULL,
  coords = NULL,
  timegroup,
  splitBy = NULL,
  threshold = NULL,
  returnDist = FALSE
)
```

Arguments

DT	input data.table
id	Character string of ID column name
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
timegroup	timegroup field in the DT within which the grouping will be calculated
splitBy	(optional) character string or vector of grouping column name(s) upon which the grouping will be calculated
threshold	(optional) spatial distance threshold to set maximum distance between an individual and their neighbour.
returnDist	boolean indicating if the distance between individuals should be returned. If FALSE (default), only ID, NN columns (and timegroup, splitBy columns if provided) are returned. If TRUE, another column "distance" is returned indicating the distance between ID and NN.

Details

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT.

The id, coords, timegroup (and optional splitBy) arguments expect the names of a column in DT which correspond to the individual identifier, X and Y coordinates, timegroup (generated by group_times) and additional grouping columns.

The threshold must be provided in the units of the coordinates. The threshold must be larger than 0. The coordinates must be planar coordinates (e.g.: UTM). In the case of UTM, a threshold = 50 would indicate a 50m distance threshold.

The timegroup argument is required to define the temporal groups within which edge nearest neighbours are calculated. The intended framework is to group rows temporally with group_times then spatially with edge_nn. If you have already calculated temporal groups without group_times, you can pass this column to the timegroup argument. Note that the expectation is that each individual will be observed only once per timegroup. Caution that accidentally including huge numbers of rows within timegroups can overload your machine since all pairwise distances are calculated within each timegroup.

The splitBy argument offers further control over grouping. If within your DT, you have multiple populations, subgroups or other distinct parts, you can provide the name of the column which identifies them to splitBy. edge_nn will only consider rows within each splitBy subgroup.

Value

edge_nn returns a data.table with three columns: timegroup, ID and NN. If 'returnDist' is TRUE, column 'distance' is returned indicating the distance between ID and NN.

The ID and NN columns represent the edges defined by the nearest neighbours (and temporal thresholds with group_times).

If an individual was alone in a timegroup or splitBy, or did not have any neighbours within the threshold distance, they are assigned NA for nearest neighbour.

See Also

Other Edge-list generation: edge_dist()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Select only individuals A, B, C for this example
DT <- DT[ID %in% c('A', 'B', 'C')]

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]
```

```
# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')

# Edge list generation
edges <- edge_nn(DT, id = 'ID', coords = c('X', 'Y'),
        timegroup = 'timegroup')

# Edge list generation using maximum distance threshold
edges <- edge_nn(DT, id = 'ID', coords = c('X', 'Y'),
        timegroup = 'timegroup', threshold = 100)

# Edge list generation, returning distance between nearest neighbours
edge_nn(DT, id = 'ID', coords = c('X', 'Y'),
        timegroup = 'timegroup', threshold = 100,
        returnDist = TRUE)
```

`fusion_id` *Fission-fusion events*

Description

`fusion_id` identifies fusion events in distance based edge lists. The function accepts a distance based edge list generated by `edge_dist`, a threshold argument and arguments controlling how fusion events are defined.

Usage

```
fusion_id(
  edges = NULL,
  threshold = 50,
  n_min_length = 0,
  n_max_missing = 0,
  allow_split = FALSE
)
```

Arguments

`edges`	distance based edge list generated by `edge_dist` function, with dyad ID generated by `dyad_ID`
`threshold`	spatial distance threshold in the units of the projection
`n_min_length`	minimum length of fusion events
`n_max_missing`	maximum number of missing observations within a fusion event
`allow_split`	boolean defining if a single observation can be greater than the threshold distance without initiating fission event

Details

The edges must be a data.table returned by the edge_dist function. In addition, fusion_id requires a dyad ID set on the edge list generated by dyad_id. If your data is a data.frame, you can convert it by reference using data.table::setDT.

The threshold must be provided in the units of the coordinates. The threshold must be larger than 0. The coordinates must be planar coordinates (e.g.: UTM). In the case of UTM, a threshold = 50 would indicate a 50 m distance threshold.

The n_min_length argument defines the minimum number of successive fixes that are required to establish a fusion event. The n_max_missing argument defines the the maximum number of allowable missing observations for the dyad within a fusion event. The allow_split argument defines if a single observation can be greater than the threshold distance without initiating fission event.

Value

fusion_id returns the input edges appended with a fusionID column.

This column represents the fusion event id. As with spatsoc's grouping functions, the actual value of fusionID is arbitrary and represents the identity of a given fusion event. If the data was reordered, the fusionID may change, but the membership of each fusion event would not.

A message is returned when a column named fusionID already exists in the input edges, because it will be overwritten.

References

See examples of identifying fission-fusion events with spatiotemporal data:

- https://doi.org/10.1111/ele.12457
- https://doi.org/10.1016/j.anbehav.2018.03.014
- https://doi.org/10.1890/08-0345.1

See Also

edge_dist

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')
```

```
# Edge list generation
edges <- edge_dist(
    DT,
    threshold = 100,
    id = 'ID',
    coords = c('X', 'Y'),
    timegroup = 'timegroup',
    returnDist = TRUE,
    fillNA = TRUE
  )

dyad_id(edges, 'ID1', 'ID2')

fusion_id(
  edges = edges,
  threshold = 100,
  n_min_length = 1,
  n_max_missing = 0,
  allow_split = FALSE
  )
```

`get_gbi` *Generate group by individual matrix*

Description

`get_gbi` generates a group by individual matrix. The function expects a `data.table` with individual identifiers and a group column. The group by individual matrix can then be used to build a network using `asnipe::get_network`.

Usage

```
get_gbi(DT = NULL, group = "group", id = NULL)
```

Arguments

`DT`	input data.table
`group`	Character string of group column (generated from one of spatsoc's spatial grouping functions)
`id`	Character string of ID column name

Details

The `DT` must be a `data.table`. If your data is a `data.frame`, you can convert it by reference using `data.table::setDT`.

The `group` argument expects the name of a column which corresponds to an integer group identifier (generated by `spatsoc`'s grouping functions).

The `id` argument expects the name of a column which corresponds to the individual identifier.

Value

get_gbi returns a group by individual matrix (columns represent individuals and rows represent groups).

Note that get_gbi is identical in function for turning the outputs of spatsoc into social networks as asnipe::get_group_by_individual but is more efficient thanks to data.table::dcast.

See Also

group_pts group_lines group_polys

Other Social network tools: randomizations()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]
DT[, yr := year(datetime)]

# EPSG code for example data
utm <- 'EPSG:32736'

group_polys(DT, area = FALSE, hrType = 'mcp',
            hrParams = list(percent = 95),
            projection = utm, id = 'ID', coords = c('X', 'Y'),
            splitBy = 'yr')

gbiMtrx <- get_gbi(DT = DT, group = 'group', id = 'ID')
```

---

group_lines *Group Lines*

Description

group_lines groups rows into spatial groups by generating LINESTRINGs and grouping based on spatial intersection. The function expects a data.table with relocation data, individual identifiers and a distance threshold. The relocation data is transformed into sf LINESTRINGs using build_lines and intersecting LINESTRINGs are grouped. The threshold argument is used to specify the distance criteria for grouping. Relocation data should be in two columns representing the X and Y coordinates.

Usage

```
group_lines(
  DT = NULL,
  threshold = NULL,
  projection = NULL,
  id = NULL,
  coords = NULL,
  timegroup = NULL,
  sortBy = NULL,
  splitBy = NULL,
  sfLines = NULL
)
```

Arguments

DT	input data.table
threshold	The width of the buffer around the lines in the units of the projection. Use threshold = 0 to compare intersection without buffering.
projection	numeric or character defining the coordinate reference system to be passed to sf::st_crs. For example, either projection = "EPSG:32736" or projection = 32736.
id	Character string of ID column name
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
timegroup	timegroup field in the DT within which the grouping will be calculated
sortBy	Character string of date time column(s) to sort rows by. Must be a POSIXct.
splitBy	(optional) character string or vector of grouping column name(s) upon which the grouping will be calculated
sfLines	Alternatively to providing a DT, provide a simple feature LINESTRING object generated with the sf package. The id argument is required to provide the identifier matching each LINESTRING. If an sfLines object is provided, groups cannot be calculated by timegroup or splitBy.

Details

R-spatial evolution:

Please note, spatsoc has followed updates from R spatial, GDAL and PROJ for handling projections, see more at https://r-spatial.org/r/2020/03/17/wkt.html.

In addition, group_lines (and build_lines) previously used sp::SpatialLines, rgeos::gIntersects, rgeos::gBuffer but have been updated to use sf::st_as_sf, sf::st_linestring, sf::st_intersects, and sf::st_buffer according to the R-spatial evolution, see more at https://r-spatial.org/r/2022/04/12/evolution.html.

Notes on arguments:

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT.

The id, coords, sortBy (and optional timegroup and splitBy) arguments expect the names of respective columns in DT which correspond to the individual identifier, X and Y coordinates, sorting, timegroup (generated by group_times) and additional grouping columns.

The projection argument expects a numeric or character defining the coordinate reference system. For example, for UTM zone 36N (EPSG 32736), the projection argument is either projection = 'EPSG:32736' or projection = 32736. See details in sf::st_crs() and https://spatialreference.org for a list of EPSG codes.

The sortBy argument is used to order the input DT when creating sf LINESTRINGs. It must a column in the input DT of type POSIXct to ensure the rows are sorted by date time.

The threshold must be provided in the units of the coordinates. The threshold can be equal to 0 if strict overlap is intended, otherwise it should be some value greater than 0. The coordinates must be planar coordinates (e.g.: UTM). In the case of UTM, a threshold = 50 would indicate a 50m distance threshold.

The timegroup argument is optional, but recommended to pair with group_times. The intended framework is to group rows temporally with group_times then spatially with group_lines (or group_pts, group_polys). With group_lines, pick a relevant group_times threshold such as '1 day' or '7 days' which is informed by your study species, system or question.

The splitBy argument offers further control building LINESTRINGs. If in your input DT, you have multiple temporal groups (e.g.: years) for example, you can provide the name of the column which identifies them and build LINESTRINGs for each individual in each year. The grouping performed by group_lines will only consider rows within each splitBy subgroup.

Value

group_lines returns the input DT appended with a "group" column.

This column represents the spatial (and if timegroup was provided - spatiotemporal) group calculated by intersecting lines. As with the other grouping functions, the actual value of group is arbitrary and represents the identity of a given group where 1 or more individuals are assigned to a group. If the data was reordered, the group may change, but the contents of each group would not.

A message is returned when a column named "group" already exists in the input DT, because it will be overwritten.

See Also

build_lines group_times

Other Spatial grouping: group_polys(), group_pts()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Subset only individuals A, B, and C
DT <- DT[ID %in% c('A', 'B', 'C')]
```

```
# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# EPSG code for example data
utm <- 32736

group_lines(DT, threshold = 50, projection = utm, sortBy = 'datetime',
            id = 'ID', coords = c('X', 'Y'))

## Daily movement tracks
# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '1 day')

# Subset only first 50 days
DT <- DT[timegroup < 25]

# Spatial grouping
group_lines(DT, threshold = 50, projection = utm,
            id = 'ID', coords = c('X', 'Y'),
            timegroup = 'timegroup', sortBy = 'datetime')

## Daily movement tracks by population
group_lines(DT, threshold = 50, projection = utm,
            id = 'ID', coords = c('X', 'Y'),
            timegroup = 'timegroup', sortBy = 'datetime',
            splitBy = 'population')
```

`group_polys` *Group Polygons*

Description

`group_polys` groups rows into spatial groups by overlapping polygons (home ranges). The function expects a `data.table` with relocation data, individual identifiers and an `area` argument. The relocation data is transformed into home range POLYGONs using `build_polys()` with adehabitatHR::mcp or adehabitatHR::kernelUD. If the `area` argument is `FALSE`, `group_polys` returns grouping calculated by spatial overlap. If the `area` argument is `TRUE`, `group_polys` returns the area area and proportion of overlap. Relocation data should be in two columns representing the X and Y coordinates.

Usage

```
group_polys(
  DT = NULL,
  area = NULL,
  hrType = NULL,
  hrParams = NULL,
  projection = NULL,
```

```
  id = NULL,
  coords = NULL,
  splitBy = NULL,
  sfPolys = NULL
)
```

Arguments

DT	input data.table
area	boolean indicating either overlap group (when FALSE) or area and proportion of overlap (when TRUE)
hrType	type of HR estimation, either 'mcp' or 'kernel'
hrParams	a named list of parameters for adehabitatHR functions
projection	numeric or character defining the coordinate reference system to be passed to sf::st_crs. For example, either projection = "EPSG:32736" or projection = 32736.
id	Character string of ID column name
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
splitBy	(optional) character string or vector of grouping column name(s) upon which the grouping will be calculated
sfPolys	Alternatively, provide solely a simple features object with POLYGONs or MULTIPOLYGONs. If sfPolys are provided, id is required and splitBy cannot be used.

Details

R-spatial evolution:

Please note, spatsoc has followed updates from R spatial, GDAL and PROJ for handling projections, see more below and details at https://r-spatial.org/r/2020/03/17/wkt.html.

In addition, group_polys previously used rgeos::gIntersection, rgeos::gIntersects and rgeos::gArea but has been updated to use sf::st_intersects, sf::st_intersection and sf::st_area according to the R-spatial evolution, see more at https://r-spatial.org/r/2022/04/12/evolution.html.

Notes on arguments:

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT().

The id, coords (and optional splitBy) arguments expect the names of respective columns in DT which correspond to the individual identifier, X and Y coordinates, and additional grouping columns.

The projection argument expects a character string or numeric defining the coordinate reference system to be passed to sf::st_crs. For example, for UTM zone 36S (EPSG 32736), the projection argument is projection = "EPSG:32736" or projection = 32736. See https://spatialreference.org for a list of EPSG codes.

The hrType must be either one of "kernel" or "mcp". The hrParams must be a named list of arguments matching those of adehabitatHR::kernelUD() or adehabitatHR::mcp().

The splitBy argument offers further control over grouping. If within your DT, you have multiple populations, subgroups or other distinct parts, you can provide the name of the column which identifies them to splitBy. The grouping performed by group_polys will only consider rows within each splitBy subgroup.

Value

When area is FALSE, group_polys returns the input DT appended with a group column. As with the other grouping functions, the actual value of group is arbitrary and represents the identity of a given group where 1 or more individuals are assigned to a group. If the data was reordered, the group may change, but the contents of each group would not. When area is TRUE, group_polys returns a proportional area overlap data.table. In this case, ID refers to the focal individual of which the total area is compared against the overlapping area of ID2.

If area is FALSE, a message is returned when a column named group already exists in the input DT, because it will be overwritten.

Along with changes to follow the R-spatial evolution, group_polys also now returns area and proportion of overlap with units explicitly specified through the units package.

See Also

build_polys() group_times()

Other Spatial grouping: group_lines(), group_pts()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# EPSG code for example data
utm <- 32736

group_polys(DT, area = FALSE, hrType = 'mcp',
            hrParams = list(percent = 95), projection = utm,
            id = 'ID', coords = c('X', 'Y'))

areaDT <- group_polys(DT, area = TRUE, hrType = 'mcp',
                      hrParams = list(percent = 95), projection = utm,
                      id = 'ID', coords = c('X', 'Y'))
print(areaDT)
```

group_pts *Group Points*

Description

group_pts groups rows into spatial groups. The function expects a data.table with relocation data, individual identifiers and a threshold argument. The threshold argument is used to specify the criteria for distance between points which defines a group. Relocation data should be in two columns representing the X and Y coordinates.

Usage

```
group_pts(
  DT = NULL,
  threshold = NULL,
  id = NULL,
  coords = NULL,
  timegroup,
  splitBy = NULL
)
```

Arguments

DT	input data.table
threshold	distance for grouping points, in the units of the coordinates
id	Character string of ID column name
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
timegroup	timegroup field in the DT within which the grouping will be calculated
splitBy	(optional) character string or vector of grouping column name(s) upon which the grouping will be calculated

Details

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT or by reassigning using data.table::data.table.

The id, coords, timegroup (and optional splitBy) arguments expect the names of a column in DT which correspond to the individual identifier, X and Y coordinates, timegroup (typically generated by group_times) and additional grouping columns.

The threshold must be provided in the units of the coordinates. The threshold must be larger than 0. The coordinates must be planar coordinates (e.g.: UTM). In the case of UTM, a threshold = 50 would indicate a 50m distance threshold.

The timegroup argument is required to define the temporal groups within which spatial groups are calculated. The intended framework is to group rows temporally with group_times then spatially with group_pts (or group_lines, group_polys). If you have already calculated temporal groups

without group_times, you can pass this column to the timegroup argument. Note that the expectation is that each individual will be observed only once per timegroup. Caution that accidentally including huge numbers of rows within timegroups can overload your machine since all pairwise distances are calculated within each timegroup.

The splitBy argument offers further control over grouping. If within your DT, you have multiple populations, subgroups or other distinct parts, you can provide the name of the column which identifies them to splitBy. The grouping performed by group_pts will only consider rows within each splitBy subgroup.

Value

group_pts returns the input DT appended with a group column.

This column represents the spatialtemporal group. As with the other grouping functions, the actual value of group is arbitrary and represents the identity of a given group where 1 or more individuals are assigned to a group. If the data was reordered, the group may change, but the contents of each group would not.

A message is returned when a column named group already exists in the input DT, because it will be overwritten.

See Also

group_times

Other Spatial grouping: group_lines(), group_polys()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Select only individuals A, B, C for this example
DT <- DT[ID %in% c('A', 'B', 'C')]

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '20 minutes')

# Spatial grouping with timegroup
group_pts(DT, threshold = 5, id = 'ID',
          coords = c('X', 'Y'), timegroup = 'timegroup')

# Spatial grouping with timegroup and splitBy on population
group_pts(DT, threshold = 5, id = 'ID', coords = c('X', 'Y'),
         timegroup = 'timegroup', splitBy = 'population')
```

group_times *Group Times*

Description

group_times groups rows into time groups. The function expects date time formatted data and a threshold argument. The threshold argument is used to specify a time window within which rows are grouped.

Usage

```
group_times(DT = NULL, datetime = NULL, threshold = NULL)
```

Arguments

DT	input data.table
datetime	name of date time column(s). either 1 POSIXct or 2 IDate and ITime. e.g.: 'datetime' or c('idate', 'itime')
threshold	threshold for grouping times. e.g.: '2 hours', '10 minutes', etc. if not provided, times will be matched exactly. Note that provided threshold must be in the expected format: '## unit'

Details

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT.

The datetime argument expects the name of a column in DT which is of type POSIXct or the name of two columns in DT which are of type IDate and ITime.

threshold must be provided in units of minutes, hours or days. The character string should start with an integer followed by a unit, separated by a space. It is interpreted in terms of 24 hours which poses the following limitations:

- minutes, hours and days cannot be fractional
- minutes must divide evenly into 60
- minutes must not exceed 60
- minutes, hours which are nearer to the next day, are grouped as such
- hours must divide evenly into 24
- multi-day blocks should divide into the range of days, else the blocks may not be the same length

In addition, the threshold is considered a fixed window throughout the time series and the rows are grouped to the nearest interval.

If threshold is NULL, rows are grouped using the datetime column directly.

Value

group_times returns the input DT appended with a timegroup column and additional temporal grouping columns to help investigate, troubleshoot and interpret the timegroup.

The actual value of timegroup is arbitrary and represents the identity of a given timegroup which 1 or more individuals are assigned to. If the data was reordered, the group may change, but the contents of each group would not.

The temporal grouping columns added depend on the threshold provided:

- threshold with unit minutes: "minutes" column added identifying the nearest minute group for each row.
- threshold with unit hours: "hours" column added identifying the nearest hour group for each row.
- threshold with unit days: "block" columns added identifying the multiday block for each row.

A message is returned when any of these columns already exist in the input DT, because they will be overwritten.

See Also

group_pts group_lines group_polys

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Cast the character column to POSIXct
DT[, datetime := as.POSIXct(datetime, tz = 'UTC')]

group_times(DT, datetime = 'datetime', threshold = '5 minutes')

group_times(DT, datetime = 'datetime', threshold = '2 hours')

group_times(DT, datetime = 'datetime', threshold = '10 days')
```

---

randomizations *Data-stream randomizations*

Description

randomizations performs data-stream social network randomization. The function expects a data.table with relocation data, individual identifiers and a randomization type. The data.table is randomized either using step or daily between-individual methods, or within-individual daily trajectory method described by Spiegel et al. (2016).

Usage

```
randomizations(
  DT = NULL,
  type = NULL,
  id = NULL,
  group = NULL,
  coords = NULL,
  datetime = NULL,
  splitBy = NULL,
  iterations = NULL
)
```

Arguments

DT	input data.table
type	one of 'daily', 'step' or 'trajectory' - see details
id	Character string of ID column name
group	generated from spatial grouping functions - see details
coords	Character vector of X coordinate and Y coordinate column names. Note: the order is assumed X followed by Y column names.
datetime	field used for providing date time or time group - see details
splitBy	List of fields in DT to split the randomization process by
iterations	The number of iterations to randomize

Details

The DT must be a data.table. If your data is a data.frame, you can convert it by reference using data.table::setDT.

Three randomization types are provided:

1. step - randomizes identities of relocations between individuals within each time step.
2. daily - randomizes identities of relocations between individuals within each day.
3. trajectory - randomizes daily trajectories within individuals (Spiegel et al. 2016).

Depending on the type, the datetime must be a certain format:

- step - datetime is integer group created by group_times
- daily - datetime is POSIXct format
- trajectory - datetime is POSIXct format

The id, datetime, (and optional splitBy) arguments expect the names of respective columns in DT which correspond to the individual identifier, date time, and additional grouping columns. The coords argument is only required when the type is "trajectory", since the coordinates are required for recalculating spatial groups with group_pts, group_lines or group_polys.

Please note that if the data extends over multiple years, a column indicating the year should be provided to the splitBy argument. This will ensure randomizations only occur within each year.

The group argument is expected only when type is 'step' or 'daily'.

For example, using data.table::year:

```
 DT[, yr := year(datetime)] randomizations(DT, type = 'step',
id = 'ID', datetime = 'timegroup', splitBy = 'yr')
```

iterations is set to 1 if not provided. Take caution with a large value for iterations with large input DT.

Value

randomizations returns the random date time or random id along with the original DT, depending on the randomization type. The length of the returned data.table is the original number of rows multiplied by the number of iterations + 1. For example, 3 iterations will return 4x - one observed and three randomized.

Two columns are always returned:

- observed - if the rows represent the observed (TRUE/FALSE)
- iteration - iteration of rows (where 0 is the observed)

In addition, depending on the randomization type, random ID or random date time columns are returned:

- step - randomID each time step
- daily - randomID for each day and jul indicating julian day
- trajectory - a random date time ("random" prefixed to datetime argument), observed jul and randomJul indicating the random day relocations are swapped to.

References

doi:10.1111/2041-210X.12553

See Also

Other Social network tools: get_gbi()

Examples

```
# Load data.table
library(data.table)


# Read example data
DT <- fread(system.file("extdata", "DT.csv", package = "spatsoc"))

# Select only individuals A, B, C for this example
DT <- DT[ID %in% c('A', 'B', 'C')]

# Date time columns
DT[, datetime := as.POSIXct(datetime)]
DT[, yr := year(datetime)]

# Temporal grouping
group_times(DT, datetime = 'datetime', threshold = '5 minutes')

# Spatial grouping with timegroup
group_pts(DT, threshold = 5, id = 'ID', coords = c('X', 'Y'), timegroup = 'timegroup')

# Randomization: step
randStep <- randomizations(
    DT,
    type = 'step',
    id = 'ID',
    group = 'group',
    datetime = 'timegroup',
    splitBy = 'yr',
    iterations = 2
)

# Randomization: daily
randDaily <- randomizations(
    DT,
    type = 'daily',
    id = 'ID',
    group = 'group',
    datetime = 'datetime',
    splitBy = 'yr',
    iterations = 2
)

# Randomization: trajectory
randTraj <- randomizations(
    DT,
    type = 'trajectory',
    id = 'ID',
    group = NULL,
    coords = c('X', 'Y'),
    datetime = 'datetime',
    splitBy = 'yr',
```

```
        iterations = 2
    )
```

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