

Package ‘RGDrivers’

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Title Analysis of Stream Network Topology and Order

Version 0.1.0

Description Provides tools for analyzing stream networks, including graph construction, calculation of Link Magnitude, D-LINK, and export of spatial data. The Link Magnitude (Shreve stream order) method follows Shreve (1966) <[doi:10.1086/627137](https://doi.org/10.1086/627137)>. The D-LINK metric follows Osborne & Wiley (1992) <[doi:10.1139/f92-076](https://doi.org/10.1139/f92-076)>.

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URL <https://github.com/diogosbr/RGDrivers>

BugReports <https://github.com/diogosbr/RGDrivers/issues>

Encoding UTF-8

Depends R (>= 4.1.0)

Imports terra, igraph, dplyr, sf, rlang

Suggests testthat (>= 3.0.0), knitr, rmarkdown

VignetteBuilder knitr

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NeedsCompilation no

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calculate_dlink	<i>Calculate the D-LINK value (downstream reach order)</i>
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Description

Adds a D_LINK column to a table of stream reaches, representing the order value (e.g. Link Magnitude) of the downstream reach.

Usage

```
calculate_dlink(df, col_id, col_downstream, col_order)
```

Arguments

- df Data frame containing the stream network reaches
- col_id Name of the column with the unique reach ID (e.g. "cotrecho")
- col_downstream Name of the column with the downstream reach ID (e.g. "nutrjus")
- col_order Name of the column with the reach order (e.g. "link_mag", "order", etc.)

Value

The same df, with a new D_LINK column

References

Osborne, L. L., & Wiley, M. J. (1992). Influence of Tributary Spatial Position on the Structure of Warmwater Fish Communities. Canadian Journal of Fisheries and Aquatic Sciences, 49(4), 671-681. doi:10.1139/f92076.

Smith, T. A., & Kraft, C. E. (2005). Stream Fish Assemblages in Relation to Landscape Position and Local Habitat Variables. Transactions of the American Fisheries Society, 134(2), 430-440. doi:10.1577/T03051.1.

Thornbrugh, D. J., & Gido, K. B. (2010). Influence of spatial positioning within stream networks on fish assemblage structure in the Kansas River basin, USA. Canadian Journal of Fisheries and Aquatic Sciences, 67(1), 143-156. doi:10.1139/f09169.

Examples

```
df <- data.frame(  
  id = c(1, 2, 3),  
  downstream = c(2, 3, NA),  
  order = c(1, 2, 3)  
)  
calculate_dlink(df, col_id = "id", col_downstream = "downstream", col_order = "order")
```

`calculate_link_magnitude`*Calculate Link Magnitude (Shreve order) for a stream network*

Description

Calculates the Link Magnitude (also known as Shreve stream order) for each reach of a stream network, assuming the network is represented as a directed acyclic graph (DAG). The Link Magnitude of a reach corresponds to the total number of independent paths from the headwaters to that reach, summing the values of its predecessors.

Usage

```
calculate_link_magnitude(graph)
```

Arguments

`graph` Directed igraph object representing the stream network (must be a DAG).

Value

A named integer vector with the Link Magnitude of each node (reach) in the network.

References

Shreve, R. L. (1966). Statistical Law of Stream Numbers. The Journal of Geology, 74(1), 17-37.
[doi:10.1086/627137](https://doi.org/10.1086/627137).

Examples

```
g <- igraph::make_graph(edges = c("1", "2", "2", "3", "3", "4"), directed = TRUE)
calculate_link_magnitude(g)
```

`calculate_outlet_distance`*Calculate the accumulated distance to the outlet*

Description

Calculates the distance from each stream reach to the outlet using directed graphs.

Usage

```
calculate_outlet_distance(network, outlet, weight = "length_km")
```

Arguments

network	igraph object representing the stream network (with edge weights)
outlet	Vector of node IDs that represent the outlet
weight	Name of the edge weight attribute (e.g. 'length_km')

Value

Named vector with accumulated distances to the outlet

Examples

```
g <- igraph::graph_from_edgelist(
  matrix(c("1", "2", "2", "3", "3", "4"), byrow = TRUE, ncol = 2),
  directed = TRUE
)
igraph::E(g)$length_km <- c(2, 3, 4)
calculate_outlet_distance(g, outlet = "4", weight = "length_km")
```

create_network_graph *Create a directed graph from a stream network*

Description

Builds an igraph graph from an sf or SpatVector object containing stream reaches. Requires columns with unique reach IDs and their respective downstream reach IDs.

Usage

```
create_network_graph(network, col_id, col_downstream)
```

Arguments

network	sf or SpatVector object representing the stream network reaches
col_id	Name of the column with the unique ID of each reach
col_downstream	Name of the column with the downstream reach ID

Value

Directed igraph object representing the stream network

Examples

```
library(igraph)
library(sf)
lines <- st_sfc(
  st_linestring(matrix(c(0,0, 1,1), ncol = 2, byrow = TRUE)),
  st_linestring(matrix(c(1,1, 2,2), ncol = 2, byrow = TRUE)),
  st_linestring(matrix(c(2,2, 3,3), ncol = 2, byrow = TRUE))
)
data <- data.frame(id = c(1, 2, 3), downstream = c(2, 3, NA))
network <- st_sf(data, geometry = lines)
g <- create_network_graph(network, col_id = "id", col_downstream = "downstream")
plot(g)
```

create_stream_network *Create a directed graph from stream reaches*

Description

Builds an igraph object from an sf object of stream reaches with ID and downstream ID columns.

Usage

```
create_stream_network(
  sf_reaches,
  col_id = "cotrecho",
  col_downstream = "nutrjus",
  col_length = NULL
)
```

Arguments

sf_reaches	sf object with line geometries and ID (col_id) and downstream (col_downstream) columns
col_id	Name of the column with the reach ID (e.g. "cotrecho")
col_downstream	Name of the column with the downstream reach ID (e.g. "nutrjus")
col_length	(Optional) Name of the column with line length, used as edge weight

Value

Directed igraph object

Examples

```
library(sf)
lines <- st_sfc(
  st_linestring(matrix(c(0,0, 1,1), ncol = 2, byrow = TRUE)),
  st_linestring(matrix(c(1,1, 2,2), ncol = 2, byrow = TRUE)),
  st_linestring(matrix(c(2,2, 3,3), ncol = 2, byrow = TRUE))
)

data <- data.frame(
  cotrecho = c(1, 2, 3),
  nutrijus = c(2, 3, NA),
  length = c(0.5, 1.2, 2.0)
)

sf_reaches <- st_sf(data, geometry = lines)

g <- create_stream_network(
  sf_reaches,
  col_id = "cotrecho",
  col_downstream = "nutrijus",
  col_length = "length"
)
plot(g)
```

```
write_network_with_orders
```

Write a spatial vector with stream order columns

Description

Inserts new columns (e.g. link_mag, D_LINK) into a SpatVector object from an updated data.frame and writes it to disk.

Usage

```
write_network_with_orders(
  original_vector,
  updated_df,
  col_id,
  additional_cols,
  output_path,
  overwrite = TRUE
)
```

Arguments

original_vector
Original SpatVector object (stream network)

updated_df	Data frame containing the reach IDs and the new columns
col_id	Name of the column with the unique reach identifier (e.g. "cotrecho")
additional_cols	Vector with the names of the columns to add to the vector
output_path	Full path to save the file to (e.g. "output.gpkg")
overwrite	Logical, if TRUE allows overwriting an existing file

Value

NULL (writes file to disk)

Examples

```
lines <- terra::vect(c(
  "LINESTRING(0 0, 1 1)",
  "LINESTRING(1 1, 2 2)"
), crs = "EPSG:4326")
lines$id <- c(1, 2)

updated_df <- data.frame(id = c(1, 2), link_mag = c(1, 2), D_LINK = c(2, NA))

output_file <- tempfile(fileext = ".gpkg")
write_network_with_orders(
  original_vector = lines,
  updated_df = updated_df,
  col_id = "id",
  additional_cols = c("link_mag", "D_LINK"),
  output_path = output_file
)
file.exists(output_file)
```

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