Package: lconnect (via r-universe)

September 5, 2024

Title Simple Tools to Compute Landscape Connectivity Metrics

Version 0.1.2

Description Provides functions to upload vectorial data and derive
landscape connectivity metrics in habitat or matrix systems.
Additionally, includes an approach to assess individual patch
contribution to the overall landscape connectivity, enabling
the prioritization of habitat patches. The computation of
landscape connectivity and patch importance are very useful in
Landscape Ecology research. The metrics available are: number
of components, number of links, size of the largest component,
mean size of components, class coincidence probability,
landscape coincidence probability, characteristic path length,
expected cluster size, area-weighted flux and integral index of
connectivity. Pascual-Hortal, L., and Saura, S. (2006)
<doi:10.1007/s10980-006-0013-z> Urban, D., and Keitt, T. (2001)
<doi:10.2307/2679983> Laita, A., Kotiaho, J., Monkkonen, M.
(2011) <doi:10.1007/s10980-011-9620-4>.

Depends R (>= 3.4.0)

License GPL-3

Encoding UTF-8

LazyData false

LinkingTo Rcpp

Imports sf, igraph, Rcpp, scales, methods

BugReports https://github.com/FMestre1/lconnect/issues

RoxygenNote 7.1.2

Repository https://fmestre1.r-universe.dev

RemoteUrl https://github.com/fmestre1/lconnect

RemoteRef HEAD

RemoteSha f508eee36c6df6477c5ac8c44781c5669b735e57

Contents

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con_metric   *Landscape connectivity metrics*

Description

Compute several landscape connectivity metrics.

Usage

```
con_metric(landscape, metric)
```

Arguments

landscape   Object of class 'lconnect' created by [upload_land](#).

metric   Character vector of landscape metrics to be computed. Can be one or more of
                 the metrics currently available: "NC", "LNK", "SLC", "MSC", "CCP", "LCP",
                 "CPL", "ECS", "AWF" and "IIC".

Details

The landscape connectivity metrics currently available are:

- NC – Number of components (groups of interconnected patches) in the landscape (Urban and
  Keitt, 2001). Patches in the same component are considered to be accessible, while patches in
  different components are not. Highly connected landscapes have less components. Threshold
  dependent, i.e., maximum distance for two patches to be considered connected, which can be
  interpreted as the maximum dispersal distance for a certain species.

- LNK – Number of links connecting the patches. The landscape is interpreted as binary, which
  means that the habitat patches are either connected or not (Pascual-Hortal and Saura, 2006).
  Higher LNK implies higher connectivity. Threshold dependent, i.e., maximum distance for
  two patches to be considered connected, which can be interpreted as the maximum dispersal
  distance for a certain species.

- SLC – Area of the largest group of interconnected patches (Pascual-Hortal and Saura, 2006).
  Threshold dependent, i.e., maximum distance for two patches to be considered connected,
  which can be interpreted as the maximum dispersal distance for a certain species.

- MSC – Mean area of interconnected patches (Pascual-Hortal and Saura, 2006). Threshold
  dependent, i.e., maximum distance for two patches to be considered connected, which can be
  interpreted as the maximum dispersal distance for a certain species.

- CCP – Class coincidence probability. It is defined as the probability that two randomly chosen points within the habitat belong to the same component (or cluster). Ranges between 0 and 1 (Pascual-Hortal and Saura, 2006). Higher CCP implies higher connectivity. Threshold dependent, i.e., maximum distance for two patches to be considered connected, which can be interpreted as the maximum dispersal distance for a certain species.

- LCP – Landscape coincidence probability. It is defined as the probability that two randomly chosen points in the landscape (whether in an habitat patch or not) belong to the same habitat component (or cluster). Ranges between 0 and 1 (Pascual-Hortal and Saura, 2006). Threshold dependent, i.e., maximum distance for two patches to be considered connected, which can be interpreted as the maximum dispersal distance for a certain species.

- CPL – Characteristic path length. Mean of all the shortest paths between the habitat patches (Minor and Urban, 2008). The shorter the CPL value the more connected the patches are. Threshold dependent, i.e., maximum distance for two patches to be considered connected, which can be interpreted as the maximum dispersal distance for a certain species.

- ECS – Expected component (or cluster) size. Mean cluster size of the clusters weighted by area. (O'Brien et al., 2006 and Fall et al, 2007). This represents the size of the component in which a randomly located point in an habitat patch would reside. Although it is informative regarding the area of the component, it does not provide any ecologically meaningful information regarding the total area of habitat. As an example: ECS increases with less isolated small components or patches, although the total habitat decreases (Laita et al. 2011). Threshold dependent, i.e., maximum distance for two patches to be considered connected, which can be interpreted as the maximum dispersal distance for a certain species.

- AWF – Area-weighted Flux. Evaluates the flow, weighted by area, between all pairs of patches (Bunn et al. 2000 and Urban and Keitt 2001). The probability of dispersal between two patches, was computed using pij=exp(-k * dij), where k is a constant making pij (the dispersal probability between patches) 50 defined by the user. Although k, as was implemented, is dependent on the dispersal distance, AWF is a probabilistic index and not directly dependent on the threshold.

- IIC – Integral index of connectivity. Index developed specifically for landscapes by Pascual-Hortal and Saura (2006). It is based on habitat availability and on a binary connection model (as opposed to a probabilistic). It ranges from 0 to 1 (higher values indicating more connectivity). Threshold dependent, i.e., maximum distance for two patches to be considered connected, which can be interpreted as the maximum dispersal distance for a certain species.

Value

Numeric vector with the landscape connectivity metrics selected.

Author(s)

Frederico Mestre

Bruno Silva

Benjamin Branoff

References

Bunn, A. G., Urban, D. L., and Keitt, T. H. (2000). Landscape connectivity: a conservation application of graph theory. Journal of Environmental Management, 59(4): 265-278.

Fall, A., Fortin, M. J., Manseau, M., and O' Brien, D. (2007). Spatial graphs: principles and applications for habitat connectivity. Ecosystems, 10(3): 448-461.

Laita, A., Kotiaho, J.S., Monkkonen, M. (2011). Graph-theoretic connectivity measures: what do they tell us about connectivity? Landscape Ecology, 26: 951-967.

Minor, E. S., and Urban, D. L. (2008). A Graph-Theory Framework for Evaluating Landscape Connectivity and Conservation Planning. Conservation Biology, 22(2): 297-307.

O'Brien, D., Manseau, M., Fall, A., and Fortin, M. J. (2006). Testing the importance of spatial configuration of winter habitat for woodland caribou: an application of graph theory. Biological Conservation, 130(1): 70-83.

Pascual-Hortal, L., and Saura, S. (2006). Comparison and development of new graph-based landscape connectivity indices: towards the priorization of habitat patches and corridors for conservation. Landscape Ecology, 21(7): 959-967.

Urban, D., and Keitt, T. (2001). Landscape connectivity: a graph-theoretic perspective. Ecology, 82(5): 1205-1218.

Examples

```
vec_path <- system.file("extdata/vec_projected.shp", package = "lconnect")
landscape <- upload_land(vec_path, bound_path = NULL,
habitat = 1, max_dist = 500)
metrics <- con_metric(landscape, metric = c("NC", "LCP"))
```

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patch_imp	*Prioritization of patches*

Description

Prioritization of patches according to individual contribution to overall connectivity.

Usage

```
patch_imp(landscape, metric, vector_out = FALSE)
```

Arguments

`landscape`	Object of class "lconnect" created by [upload_land].
`metric`	String indicating the connectivity metric to use in the prioritization.
`vector_out`	TRUE/FALSE indicating if the resulting spatial object should be recorded to file.

Details

Each patch is removed at a time and connectivity metrics are recalculated without that specific patch. Patch importance value indicates the percentage of reduction in the connectivity metric that the loss of that patch represents in the landscape. The current version only allows the use of IIC or AWF.

Value

An object of class "pimp". This object is a list with the following values:

landscape	Spatial polygon object of class "sf" (package "sf") with cluster identity and importance of each polygon.
prioritization	Vector with patch importance in percentage.

Author(s)

Frederico Mestre

Bruno Silva

References

Saura, S., Pascual-Hortal, L. (2007). A new habitat availability index to integrate connectivity in landscape conservation planning: Comparison with existing indices and application to a case study. Landscape and Urban Planning, 83(2-3):91-103.

Examples

```
vec_path <- system.file("extdata/vec_projected.shp", package = "lconnect")
landscape <- upload_land(vec_path, bound_path = NULL,
                         habitat = 1, max_dist = 500)
importance <- patch_imp(landscape, metric = "IIC")
plot(importance)
```

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plot.lconnect   *Plot object of class "lconnect"*

Description

Method of the generic [plot](#) for objects of class "lconnect".

Usage

```
## S3 method for class 'lconnect'
plot(x, ...)
```

Arguments

x	Object of class "lconnect" created by [upload_land](#).
...	Other options passed to [plot](#) or or [plot.sf](#).

Details

Plot patches with different colours representing cluster membership. Additional arguments accepted by '[plot](#) or [plot.sf](#) can be included.

Value

Plot depicting patches and cluster membership (distinct colours per cluster).

Author(s)

Bruno Silva

Frederico Mestre

`plot.pimp`   *Plot pimp object*

Description

Method of the generic [plot](#) for objects of class "pimp".

Usage

```
## S3 method for class 'pimp'
plot(x, ..., main)
```

Arguments

x	Object of class "pimp" created by [patch_imp](#).
...	Other options passed to [plot](#) or [plot.sf](#).
main	String with plot title.

Details

Plot patch importance with percentage value per patch. This value indicates the percentage of reduction in the connectivity metric that the loss of that patch represents in the landscape. Additional arguments accepted by [plot](#) or [plot.sf](#) can be included.

Value

Patch importance plot.

Author(s)

Bruno Silva

Frederico Mestre

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upload_land   *Import and convert a shapefile to an object of class "lconnect"*

Description

Import and convert a shapefile to an object of class "lconnect". Some landscape and patch metrics which are the core of landscape connectivity metrics are calculated. The shapefile must be projected, i.e., in planar coordinates and the first field must contain the habitat categories.

Usage

```
upload_land(land_path, bound_path = NULL, habitat, max_dist = NULL)
```

Arguments

land_path	String indicating the full path of the landscape shapefile.
bound_path	String indicating the full path of the boundary shapefile. If NULL (default option) a convex hull will be created and used as boundary.
habitat	Vector with habitat categories. The categories can be numeric or character.
max_dist	Numeric indicating the maximum distance between patches in the same cluster.

Value

An object of class "lconnect". This object is a list with the following values:

landscape	Spatial polygon object of class "sf" (package "sf") with cluster membership of each polygon.
max_dist	Numeric indicating the maximum distance between patches of the same cluster.
clusters	Numeric vector indicating cluster identity of each polygon.
distance	Object of class "dist" (package "stats") with eucledian distances between all pairs of polygons.
boundary	Spatial polygon of class "sfc" (package "sf") representing the boundary of the landscape.
area_l	Numeric with the total area of the boundary, in square units of landscape units.

Author(s)

Bruno Silva

Frederico Mestre

Examples

```
vec_path <- system.file("extdata/vec_projected.shp",
package = "lconnect")
landscape <- upload_land(vec_path, bound_path = NULL,
habitat = 1, max_dist = 500)
plot(landscape)
```

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