Package 'lconnect'

March 22, 2019

Title Simple Tools to Calculate Landscape Connectivity Metrics

Version 0.1.0

Description Simple tools to calculate landscape connectivity metrics. The objective of this package is to provide a simple to use approach to calculate landscape connectivity metrics.

Depends R (>= 3.4.4)

License GPL-3

Encoding UTF-8

LazyData true

Imports sf,
igraph

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

RoxygenNote 6.1.1

R topics documented:

`con_metric` *Landscape connectivity metrics*

Description

Calculates several landscape connectivity metrics

Usage

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

Arguments

`landscape`	landscape object created by `upload_land`
`metric`	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 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

vector with the landscape connectivity metrics selected.

Author(s)

Frederico Mestre

Bruno Silva

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.

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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.

Saura, S., and 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): 91-103.

Saura, S., Estreguil, C., Mouton, C. & Rodriguez-Freire, M. (2011a). Network analysis to assess landscape connectivity trends: application to European forests (1990-2000). Ecological Indicators 11: 407-416.

Saura, S., Gonzalez-Avila, S. & Elena-Rossello, R. (2011b). Evaluacion de los cambios en la conectividad de los bosques: el indice del area conexa equivalente y su aplicacion a los bosques de Castilla y Leon. Montes, Revista de Ambito Forestal 106: 15-21

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"))
```

`patch_imp` *Prioritization of patches*

Description

Prioritization of patches according to individual contribution to overall connectivity.

Usage

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

Arguments

`landscape`	lconnect object 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.

Value

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

`landscape`	spatial polygon object of class "sf" with cluster identity and importance of each polygon
`prioritization`	vector with patch importance

Author(s)

Frederico Mestre

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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)
```

`plot.lconnect` *Plot lconnect object*

Description

Method of the generic `plot` for lconnect objects.

Usage

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

Arguments

`x`	lconnect object generated by `upload_land`
`...`	other options passed to `plot`.

Details

Plot patches with different colours representing cluster identity. Aditional arguments accepted by `plot` or `plot.sf` can be included.

Value

Plot with clusters

Author(s)

Bruno Silva

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plot.pimp *Plot pimp object*

Description

Method of the generic plot for pimp objects.

Usage

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

Arguments

x	pimp object generated 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. Aditional arguments accepted by plot or plot.sf can be included.

Value

Plot with patch importance

Author(s)

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upload_land *Import and convert a shapefile to a lconnect object*

Description

Import and convert a shapefile to a lconnect object. 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 be 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" with cluster identity 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" with eucledian distances between all pairs of polygons
`boundary`	spatial polygon of class "sfc" representing the boundary of the landscape
`area_l`	numeric with the total area of the boundary, in square units of landscape units

Author(s)

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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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