Package ‘enerscape’

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Type Package

Title Compute Energy Landscapes

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Author Emilio Berti

Maintainer Emilio Berti <emilio.berti@idiv.de>

Description Compute energy landscapes using a digital elevation model raster and body mass of animals. Vignette available at: <https://emilio-berti.github.io/enerscape.html>.

License GPL-3

Encoding UTF-8

LazyData true

Imports raster, gdistance, rgdal, rgeos, sp, Matrix

Suggests knitr, rmarkdown

RoxygenNote 7.1.1

Depends R (>= 2.10)

NeedsCompilation no

Repository CRAN

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R topics documented:

.calc_arc *Compute energy costs*

Description

Internal function for enerscape - calculate work.

Usage

```
.calc_arc(slope, m, work_in_kcal = TRUE, j_to_kcal = 4184)
```

Arguments

`slope`	slope transition matrix.
`m`	species body mass (kg).
`work_in_kcal`	if work should be expressed in kilocalories.
`j_to_kcal`	joules to kilocalories conversion constant.

Details

Internal function of enerscape, don't call directly.

Value

A transition layer with values the energy cost of movement between cells (J or kcal).

.calc_arc_cond *Compute conductance*

Description

Internal function for enerscape - calculate conductance

Usage

```
.calc_arc_cond(slope, m, work_in_kcal = TRUE, j_to_kcal = 4184)
```

Arguments

`slope`	slope transition matrix.
`m`	species body mass (kg).
`work_in_kcal`	if work should be expressed in kilocalories.
`j_to_kcal`	joules to kilocalories conversion constant.

Details

Internal function of enerscape, don't call directly.

Value

A transition layer with values the conductance between cells, i.e. the distance that can be traveled per unit of energy (1 / J or 1 / kcal).

.calc_cycling *Compute energy costs for a cyclist*

Description

Internal function for enerscape - calculate work.

Usage

```
.calc_cycling(height, slope, m, v, work_in_kcal = TRUE, j_to_kcal = 4184)
```

Arguments

height	height transition matrix.
slope	slope transition matrix.
m	species body mass (kg).
v	speed of cyclist.
work_in_kcal	if work should be expressed in kilocalories.
j_to_kcal	joules to kilocalories conversion constant.

Details

Internal function of enerscape, don't call directly. This assumes no wind, a bike of 7 kg, optimal pedal frequency, and constant mechanical efficiency of 25

Value

A transition layer with values the energy cost of movement between cells (J or kcal).

.calc_cycling_cond *Compute conductance for a cyclist*

Description

Internal function for enerscape - calculate work.

Usage

```
.calc_cycling_cond(height, slope, m, v, work_in_kcal = TRUE, j_to_kcal = 4184)
```

Arguments

height	height transition matrix.
slope	slope transition matrix.
m	species body mass (kg).
v	speed of cyclist.
work_in_kcal	if work should be expressed in kilocalories.
j_to_kcal	joules to kilocalories conversion constant.

Details

Internal function of enerscape, don't call directly. This assumes no wind, a bike of 7 kg, optimal pedal frequency, and constant mechanical efficiency of 25

Value

A transition layer with values the energy cost of movement between cells (J or kcal).

circuitscape_skeleton *Create the initialization file for the julia package Circuitscape*

Description

This creates the init file for the julia package Circuitscape: https://juliapackages.com/p/circuitscape.

Usage

```
circuitscape_skeleton(en = NULL, path = NULL, points = NULL)
```

Arguments

`en`	an enerscape object.
`path`	full path where to write the .ini file.
`points`	data.frame with origin and destination coordinates.

Value

Nothing, only write the circuitscape.ini file to disk.

`enerscape` *Compute the energy landscape*

Description

This is the main function to compute energy landscapes from a digital elevation model and body mass of animals based on the model from Pontzer (2016). The core of the computations are done using the *gdistance* (Etten, 2017) package.

Usage

```
enerscape(dem, m, unit = "joule", neigh = 16, method = "ARC", v = NULL)
```

Arguments

`dem`	raster file of the digital elevation model, either a raster or a full path location of the file.
`m`	species body mass (kg).
`unit`	if joules ('joule') or kilocalories ('kcal').
`neigh`	number of neighbor cells that are connected together.
`method`	method to use to compute the energy costs. 'ARC' refers to the model from Pontzer (2016) and 'cycling' to the model for cyclist from di Prampero et al. (1979).
`v`	speed of cyclist (km / h), only for `method = 'cycling'`.

Details

From the digital elevation model, transition slopes, energy costs and conductances (1 / work) are computed based on the model described in Pontzer (2016).

Value

A list with elements a rasterStack of the digital elevation model, slope, energy landscape, and conductance and the conductance as a transitionLayer for path analysis.

References

Etten, J. van. (2017). R Package gdistance: Distances and Routes on Geographical Grids. Journal of Statistical Software, 76(1), 1–21. doi: 10.18637/jss.v076.i13.

Pontzer, H. (2016). A unified theory for the energy cost of legged locomotion. Biology Letters, 12(2), 20150935. doi: 10.1098/rsbl.2015.0935.

di Prampero, P. E., Cortili, G., Mognoni, P., & Saibene, F. (1979). Equation of motion of a cyclist. Journal of Applied Physiology, 47(1), 201–206. doi: 10.1152/jappl.1979.47.1.201

Examples

```
library(raster)
data("volcano")
dem <- raster(volcano)
en <- enerscape(dem, 10, unit = "kcal", neigh = 16)
```

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en_extrapolation *Check if model extrapolates*

Description

This check if computation of the energy landscape extrapolates from the test set of enerscape::pontzer (2016).

Usage

```
en_extrapolation(en, plot = TRUE)
```

Arguments

`en`	an enerscape object.
`plot`	plot areas where slope is extrapolated.

Details

Check if body mass or incline are outside the test range of the model. If slope extrapolations are detected and `plot = TRUE`, a plot of where extrapolations occur is displayed.

Value

A list with booleans if body size or inclines extrapolates and a rasterLayer for where incline extrapolates. The rasterLayer is returned only if extrapolations are present.

References

enerscape::pontzer, H. (2016). A unified theory for the energy cost of legged locomotion. Biology Letters, 12(2), 20150935. doi: 10.1098/rsbl.2015.0935.

Examples

```
library(raster)
library(enerscape)
data("volcano")
dem <- raster(volcano)
en <- enerscape(dem, 10, unit = "kcal", neigh = 16)
en_extrapolation(en, plot = TRUE)
```

---

en_lcp *Compute least-cost paths*

Description

Calculate the least-cost path (lcp) between origin and destination

Usage

```
en_lcp(en, or, dest, simulate_random_points = FALSE, rep = 10, plot = TRUE)
```

Arguments

en	an enerscape object obtained with `enerscape()`.
or	origin point.
dest	destination point.
simulate_random_points	if to simulate least-cost path among random points. default = FALSE.
rep	number or random origin and destination points if `simulate_random_points = TRUE`. default = 10.
plot	if to plot the output.

Details

If `or` and `dest` are not specified, the least-cost path is specified by setting `simulate_random_points = TRUE` and `rep` equal to the number of random paths to compute.

Value

A list with point locations, least-cost path as SpatialLines, energy costs and distances.

Examples

```
library(raster)
data("volcano")
dem <- raster(volcano)
en <- enerscape(dem, 10, unit = "kcal", neigh = 16)
p <- xyFromCell(dem, sample(ncell(dem), 2))
lcp <- en_lcp(en, or = p[1, ], dest = p[2, ])
```

en_passage *Compute probability of passage of random walks*

Description

Calculate the net number of passages of random walks between origin and destination.

Usage

```
en_passage(
  en,
  or,
  dest,
  theta = 4,
  simulate_random_points = FALSE,
  rep = 10,
  plot = TRUE
)
```

Arguments

`en`	an enerscape object obtained with `enerscape()`.
`or`	origin point.
`dest`	destination point.
`theta`	the degree from which the path randomly deviates from the least-cost path.
`simulate_random_points`	if to simulate least-cost path among random points. default = FALSE.
`rep`	number or random origin and destination points if `simulate_random_points` = `TRUE`. default = 10.
`plot`	if to plot the output.

Details

If `or` and `dest` are not specified, the least-cost path is specified by setting `simulate_random_points` = `TRUE` and `rep` equal to the number of random paths to compute.

Value

A list with point locations, rasterLayer of net passage of random walks, and rasterLayer of cumulative net passage if `simulate_random_points` = `TRUE`.

Examples

```
library(raster)
data("volcano")
dem <- raster(volcano)
en <- enerscape(dem, 10, unit = "kcal", neigh = 16)
p <- xyFromCell(dem, sample(ncell(dem), 2))
walk <- en_passage(en, or = p[1, ], dest = p[2, ], theta = 4)
```

`en_path` *Compute the energy costs for a chosen path*

Description

This returns the distance and energy costs of traveling a chosen path. Optionally, the path can be selected by specifying the number of nodes and clicking on the plot.

Usage

```
en_path(en, p = NULL, draw = FALSE, n = NULL, plot = TRUE)
```

Arguments

`en`	an enerscape object.
`p`	path as SpatialLines.
`draw`	if TRUE the path will be chosen by drawing it on the map/
`n`	number of node points for the path.
`plot`	if TRUE plot the path

Value

A list with elements the path, its travel distance and energy costs.

References

Etten, J. van. (2017). R Package gdistance: Distances and Routes on Geographical Grids. Journal of Statistical Software, 76(1), 1–21. doi: 10.18637/jss.v076.i13.

Pontzer, H. (2016). A unified theory for the energy cost of legged locomotion. Biology Letters, 12(2), 20150935. doi: 10.1098/rsbl.2015.0935.

di Prampero, P. E., Cortili, G., Mognoni, P., & Saibene, F. (1979). Equation of motion of a cyclist. Journal of Applied Physiology, 47(1), 201–206. doi: 10.1152/jappl.1979.47.1.201

Examples

```
library(raster)
library(enerscape)
data("volcano")
dem <- raster(volcano)
en <- enerscape(dem, 10, unit = "kcal", neigh = 16)
```

---

omniscape_skeleton — *Create the initialization file for the julia package Omniscape*

Description

This creates the init file for the julia package Omniscape: https://juliapackages.com/p/omniscape.

Usage

```
omniscape_skeleton(en = NULL, path = NULL, radius = NULL, aggr_fact = 1)
```

Arguments

en	an enerscape object.
path	full path where to write the .ini file.
radius	radius in pixels of the moving window.
aggr_fact	the block size to compute the Omniscape.

Value

Nothing, only write the omniscape.ini file to disk.

---

pontzer — *Energy cost of transport from Pontzer (2016)*

Description

Energy cost of transport from Pontzer (2016)

Usage

```
pontzer
```

Format

A data frame with 92 rows and 5 variables:

Species species name

Incline incline of movement

Mass species body mass

Cost.of.Transport cost of transport

Source original source of data

Source

doi: 10.1098/rsbl.2015.0935

References

#' Pontzer, H. (2016). A unified theory for the energy cost of legged locomotion. Biology Letters, 12(2), 20150935.

Index