

Package ‘grec’

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Type Package

Title Gradient-Based Recognition of Spatial Patterns in Environmental Data

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URL <https://github.com/LuisLauM/grec>

BugReports <https://github.com/LuisLauM/grec/issues>

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Description Provides algorithms for detection of spatial patterns from oceanographic data using image processing methods based on Gradient Recognition.

License GPL (>= 3)

Depends R (>= 3.2.0)

Imports utils, imagine (>= 2.0.0), raster, terra, abind

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R topics documented:

grec-package	2
chl	2
colPalette	2
detectFronts.RasterLayer	3
sst	6

Index	7
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grec-package	<i>G</i> radient-based <i>RE</i> Cognition of spatial patterns in environmental data
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Description

Provides algorithms for detecting spatial patterns from 2-D oceanographic data using image processing methods based on Gradient Recognition.

Author(s)

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chl	<i>Sea Surface Chlorophyll Data</i>
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Description

Surface chlorophyll maps downloaded from ERDDAP for running examples with grec functions.

Usage

chl

Format

A list with chlorophyll information from February to April of Aqua MODIS source.

References

ERDDAP website: <https://coastwatch.pfeg.noaa.gov/erddap/index.html>

colPalette	<i>Default color palette most using on environmental representations.</i>
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Description

Vector with 2000 colors generated from tim.colors function.

Usage

colPalette

Format

A vector of 2000 colors in RGB format.

References

tim.colors from **fields** package

detectFronts.RasterLayer

Apply gradient-based methodologies to environmental data

Description

This function takes a numeric matrix, array, XYZ-list, SpatRaster or RasterLayer* and allows the users to apply methodologies based on gradient-searching.

Usage

```
## S3 method for class 'RasterLayer'
detectFronts(x, method = "BelkinOReilly2009", intermediate = FALSE, ...)

## S3 method for class 'SpatRaster'
detectFronts(x, method = "BelkinOReilly2009", intermediate = FALSE, ...)

## S3 method for class 'array'
detectFronts(x, method = "BelkinOReilly2009", intermediate = FALSE, ...)

## Default S3 method:
detectFronts(
  x,
  method = "BelkinOReilly2009",
  intermediate = FALSE,
  ConvolNormalization = FALSE,
  ...
)

detectFronts(
  x,
  method = "BelkinOReilly2009",
  intermediate = FALSE,
  ConvolNormalization = FALSE,
  ...
)

## S3 method for class 'list'
detectFronts(x, method = "BelkinOReilly2009", intermediate = FALSE, ...)
```

```
## S3 method for class 'matrix'
detectFronts(x, method = "BelkinOReilly2009", intermediate = FALSE, ...)
```

Arguments

<code>x</code>	Main input of class <code>matrix</code> , array, XYZ list, <code>SpatRaster</code> or <code>RasterLayer*</code> . See 'Details.'
<code>method</code>	character string indicating the method that will be used. For the available methods, see 'Details'.
<code>intermediate</code>	logical indicating whether to get the intermediate matrices (TRUE) or just the final one (FALSE).
<code>...</code>	Extra arguments that will depend on the selected method. See Details.
<code>ConvolNormalization</code>	logical indicating if convolutions will perform a previous normalization (FALSE by default). See Details.

Details

grec works in joint to **imagine** package in order to perform and apply image processing algorithms for the identification of oceanic fronts. **imagine** provides the basic algorithms developed in a efficient way (using C++ tools). On the other hand, **grec** is in charge of managing the use of this coding tools in the context of oceanic gradient recognition and dealing with the developing of input/output methods. In that regard, the available methods that **grec** offer will depend the versions of installed **grec-imagine**.

`RasterLayer*`: As the news of **raster** package will no longer available, `RasterLayer` will not longer supported in future versions of **grec**. On the other hand, methods for `SpatRaster` will started to be avavilable since v.1.5.0.

Until the current version, **grec** performs two methods:

1. `BelkinOReilly2009` (default): Based on Belkin & O'Reilly (2009) article, it uses a Contextual Median Filter (CMF) for smoothing the original data before the applying of Sobel filters.
2. `median_filter`: it uses a typical median filter (MF) for smoothing the original data. It also allows the user to change the window size for median filter (3 as default).

`x` could be given as a single numeric matrix from an environmental map. Othersiwe it also can be set as a three-dimension XYZ list: 'x' (a vector of longitudes), 'y' (vector of latitudes) and 'z' as a matrix of dimensions `length(x$x)xxlength(x$y)`. You can also specify `x` as an array, `SpatRaster` or `RasterLayer*` object. If `x` is an array, it must be of 3 dimensions: lon, lat and time. It is not required to specify the dimnames. The output will preserve all the attributes of input.

`...` allows the (advanced) users to modify some aspects of filter application. Depending on the selected methodology, some parameters can be modified:

times numeric. How many times do you want to apply the filtering method?

kernelValues numeric. Vector with which are going to be used in convolution to identify Vertical and Horizontal gradients.

radius numeric. If median filter method was selected, it allows to change the window size of the filter.

Normalization is a common practice in convolution in order to ensure that outputs are weighted within original range of values. It is achieved dividing outputs of convolution by `sum(abs(kernel))`. It is hardly recommended to use normalization in order to have always coherent values in regards of the original inputs; however, it is deactivated by default and user can switch it on by setting `ConvolNormalization = TRUE`.

Finally, Belkin & O'Reilly work proposed a log transformation after the gradient calculation. This step has NOT been considered as default in the function due to its application is focused on Chlorophyll values, so the user must decide to apply it or not manually before.

Value

The output will preserve the input class (matrix, array, list or RasterLayer).

References

Belkin, I. M., & O'Reilly, J. E. (2009). An algorithm for oceanic front detection in chlorophyll and SST satellite imagery. *Journal of Marine Systems*, 78(3), 319-326 ([doi:10.1016/j.jmarsys.2008.11.018](https://doi.org/10.1016/j.jmarsys.2008.11.018)).

Examples

```
data(sst)
exampleSSTData <- list(x = sst$longitude,
                      y = sst$latitude,
                      z = sst$sst[, , 1])

data(chl)
exampleChlData <- list(x = chl$longitude,
                      y = chl$latitude,
                      z = chl$chlorophyll[, , 1])

# Simple application (over a XYZ list)
out_sst <- detectFronts(x = exampleSSTData)
out_chl <- detectFronts(x = exampleChlData)

# External transformation for chl data
out_chl$z <- log10(out_chl$z)

par(mfrow = c(2, 2), mar = rep(0, 4), oma = rep(0, 4))

image(exampleSSTData, col = colPalette, axes = FALSE)
mtext(text = "Original SST", side = 3, line = -2, adj = 0.99, cex = 1.2)

image(out_sst, col = colPalette, axes = FALSE)
mtext(text = "SST gradient", side = 3, line = -2, adj = 0.99, cex = 1.2)

image(exampleChlData, col = colPalette, axes = FALSE)
mtext(text = "Original Chlorophyll", side = 3, line = -2, adj = 0.99, cex = 1.2)

image(out_chl, col = colPalette, axes = FALSE)
mtext(text = "Chlorophyll gradient\n(log scale)", side = 3, line = -4, adj = 0.99,
      cex = 1.2)
```

sst

Sea Surface Temperature Data

Description

SST maps downloaded from ERDDAP for running examples with grec functions.

Usage

sst

Format

A list with SST information from February to April of Aqua MODIS source.

References

ERDDAP website: <https://coastwatch.pfeg.noaa.gov/erddap/index.html>

Index

* **environmental-data**

grec-package, [2](#)

* **gradient**

grec-package, [2](#)

* **pattern-detection**

grec-package, [2](#)

chl, [2](#)

colPalette, [2](#)

detectFronts

(detectFronts.RasterLayer), [3](#)

detectFronts.RasterLayer, [3](#)

grec (grec-package), [2](#)

grec-package, [2](#)

sst, [6](#)