Package 'shapeR'

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Type Package

Title Collection and Analysis of Otolith Shape Data

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Depends R (>= 3.0.2)

Imports plotrix, jpeg, pixmap, wavethresh, methods, vegan, MASS

Description Studies otolith shape variation among fish populations.
Otoliths are calcified structures found in the inner ear of teleost fish and their shape has
been known to vary among several fish populations and stocks, making them very useful in taxonomy,
species identification and to study geographic variations. The package extends previously described
software used for otolith shape analysis by allowing the user to automatically extract closed
contour outlines from a large number of images, perform smoothing to eliminate pixel noise described in Haines and Crampton (2000) <doi:10.1111/1475-4983.00148>,
choose from conducting either a Fourier or wavelet see Gençay et al (2001) <doi:10.1016/S0378-4371(00)00463-5> transform to the outlines and visualize
the mean shape. The output of the package are independent Fourier or wavelet coefficients
which can be directly imported into a wide range of statistical packages in R. The package
might prove useful in studies of any two dimensional objects.

License GPL (>= 2)

URL https://github.com/lisalibungan/shapeR,

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0121102

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NeedsCompilation no

Repository CRAN

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Contents

| cluster.plot | *Plot data clusters* |

Description

Plots data clusters

Usage

```
cluster.plot( ddata, classes, main="", col.stock=NULL,
              plotCI = FALSE, conf.level = 0.68, ...)
```

Arguments

`ddata`	Matrix of points
`classes`	A factor including the cluster values
`main`	Title for the plot
`col.stock`	Colors for the plotted classes
`plotCI`	Plot means with confidence intervals
`conf.level`	The confidence interval for the standard error of the mean
`...`	Additional parameters to be passed to 'plot' or 'ldahist' if one dimension

Value

None

Author(s)

Lisa Anne Libungan

References

Oksanen, J., Blanchet, F.G., Kindt, R., Legendre, P., Minchin, P.R., O'Hara, R.B., Simpson, G.L., Solymos, P., Stevens, M.H.H. and Wagner, H. (2013). vegan: Community Ecology Package. R package version 2.0-10.

Examples

```
data(shape)
library(vegan)
cap.res = capscale(getStdWavelet(shape) ~ getMasterlist(shape)$pop)

eig=eigenvals(cap.res,constrained=TRUE)
eig.ratio = eig/sum(eig)

cluster.plot(scores(cap.res)$sites[,1:2],getMasterlist(shape)$pop
,plotCI=TRUE
,xlab=paste("CAP1 (",round(eig.ratio[1]*100,1),"%)",sep="")
,ylab=paste("CAP2 (",round(eig.ratio[2]*100,1),"%)",sep="")
,main="Canonical clustering"
)
```

`detect.outline`   *Detect otolith outline*

Description

Determine the outline of otolith images in jpeg format which have been stored in the `Fixed` folder.

Usage

```
detect.outline(object, threshold=0.2, mouse.click=FALSE,
          display.images=FALSE, write.outline.w.org=FALSE)
```

Arguments

object	[shapeR](#) object
threshold	Grayscale threshold. Value between 0 and 1.
mouse.click	If TRUE, the user clicks where the starting point for the otolith contour extraction algorithm should start. Default is the center of the image. Could be good to set as TRUE if the otolith detection produces an error.
display.images	If TRUE, each image is displayed and the user can visualize how the outline is captured
write.outline.w.org	
	If TRUE, the outline is written on top of the original image using the function [write.image.with.outline](#), and can be seen in the `Original_with_outline` folder

Details

Based on the Conte function (Claude 2008)

Value

A [shapeR](#) object with otolith outlines in the slot outline.list

Author(s)

Lisa Anne Libungan & Snaebjorn Palsson

References

Claude, J. (2008). Morphometrics with R. Springer. 316 p.

Urbanek, S. (2014). [jpeg](#): Read and write JPEG images. R package version 0.1-8.

Bivand, R., Leisch, F. & Maechler, M. (2011) [pixmap](#): Bitmap Images ("Pixel Maps"). R package version 0.4-11.

Libungan LA and Palsson S (2015) ShapeR: An R Package to Study Otolith Shape Variation among Fish Populations. PLoS ONE 10(3): e0121102. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0121102

Examples

```
## Not run:
#Use test data from Libungan and Palsson (2015):
shape = shapeR("ShapeAnalysis/","FISH.csv")
shape = detect.outline(shape, threshold=0.2,write.outline.w.org = TRUE)
## End(Not run)
```

---

enrich.master.list	*Link information in the info.file to the coefficients obtained from the otolith images*

Description

Link the original info file to the otolith coefficients

Usage

```
enrich.master.list(object, folder_name = "folder", pic_name = "picname",
            calibration = "cal", include.wavelet = TRUE, include.fourier = TRUE,
                n.wavelet.levels = 5, n.fourier.freq = 12,...)
```

Arguments

object	A [shapeR](#) object
folder_name	Should contain the first letters of the area and the serie or station number of the sample, for example: "IC"
pic_name	Should contain the serie number of a given sample and fish number, for example "403_2" (not including the .jpg extension)
calibration	The name of the column where the pixels to measurement calibration is located
include.wavelet	If TRUE, the wavelet coefficient are included in the master.list
include.fourier	If TRUE then the Normalized Elliptic Fourier coefficients are included in the master.list
n.wavelet.levels	Integer saying how many levels of wavelet levels should be included
n.fourier.freq	Integer saying how many Fourier frequency levels should be included
...	Additional parameter for read.csv for reading the info.file

Value

A [shapeR](#) object with values in slots:

- wavelet.coef
- fourier.coef
- shape
- filter
- master.list

Author(s)

Lisa Anne Libungan

Examples

```
data(shape)
shape = generateShapeCoefficients(shape)

shape = enrich.master.list(shape)
```

---

estimate.outline.reconstruction

Estimate the outline reconstruction based on Fourier/wavelet compared to the outlines that have not been transformed

---

Description

Estimate outline reconstruction using a different number of coefficients of wavelet and Fourier compared to the original otolith

Usage

```
estimate.outline.reconstruction(object, ...)
```

Arguments

object	[shapeR] object
...	Additional parameters to be passed to 'plot' and 'points'

Value

A list containing values

- w.dev.m a list for number of coefficients for mean error of wavelet reconstruction
- w.dev.sd a list for number of coefficients for standard deviation of wavelet reconstruction
- f.power.total Fourier power for number of Fourier harmonics

Author(s)

Lisa Anne Libungan

References

Claude, J. (2008) Morphometrics with R. Springer. 316 p.

Examples

```
## Not run:
data(shape)
estimate.outline.reconstruction(shape)
## End(Not run)
```

FISH   *An example data file*

Description

The file's columns are:

- country
- station
- pop
- stockID
- day
- month
- year
- lat
- lon
- fishno
- length_cm
- weight_g
- age
- sex
- maturity
- folder
- picname
- cal

Usage

```
data(FISH)
```

Format

An example data file

Source

<https://github.com/lisalibungan/shapeR>

---

generateShapeCoefficients

Get wavelet/Fourier coefficients and basic shape variables

Description

Generates shape variables based on Fourier/wavelet reconstruction. Wavelet coefficients for wavelet. Basic shape parameters are also collected (area, length, width, perimeter).

Usage

```
generateShapeCoefficients(object,...)
```

Arguments

object   [shapeR](#) object

...   Additional parameters to be passed to the [wd](#) function of the [wavethresh](#) package for the wavelet decomposition of the otolith outlines

Value

A [shapeR](#) object with values in slots:

- wavelet.coef.raw
- fourier.coef.raw
- shape.coef.raw

Author(s)

Lisa Anne Libungan & Snaebjorn Palsson

References

Nason, G. (2012). [wavethresh](#): Wavelets statistics and transforms. R package, version 4.5.

Claude, J. (2008). Morphometrics with R. Springer. 316 p.

See Also

[wavethresh](#)

Examples

```
data(shape)
shape = generateShapeCoefficients(shape)
```

---

getFourier *Get Fourier coefficients, filtered according to filter*

Description

Returns the Fourier coefficients determined in [stdCoefs](). Returns only values as set in [setFilter]()

Usage

```
getFourier(object)
```

Arguments

object   [shapeR]() object

Value

The Fourier coefficients for all fish as determined by [setFilter]()

Author(s)

Lisa Anne Libungan

---

getMasterlist *Get filtered master.list values*

Description

Returns selected values from `master.list`

Usage

```
getMasterlist(object, useFilter = TRUE)
```

Arguments

object   [shapeR]() object
useFilter   If TRUE, the master.list values are filtered by the slot `filter`. FALSE = no filtering.

Value

The `master.list` is filtered by the slot `filter` if the useFilter is TRUE, else no filtering is done.

Author(s)

Lisa Anne Libungan

---

getMeasurements *Get simple shape variables, filtered according to filter*

Description

Returns shape variables length, width, perimeter and area determined in generateShapeCoefficients. Returns only values as set in the slot filter. These variables can only be obtained if the calibration measurements in pixels have been registered in the csv data file in a column labelled 'cal' (see example data file). To get the calibration measurements, use a image manipulation program and measure 1mm on the calibration measurement stick (that was taken for that particular dataset) and register how many pixels 1mm is into the column 'cal'.

Usage

```
getMeasurements(object)
```

Arguments

object   shapeR object

Value

A data frame with all valid fish as determined by the slot filter and with columns:

- otolith.area
- otolith.length
- otolith.width
- otolith.perimeter

Author(s)

Lisa Anne Libungan

Examples

```
data(shape)
# Calculate the mean otolith area for each fish population
# The results are in square mm since the calibration ('cal') column
# in the data file is in pixels (1 mm/pixel).
tapply(getMeasurements(shape)$otolith.area, getMasterlist(shape)$pop,mean)
```

---

getStdFourier *Get standardized Fourier coefficients, filtered according to filter*

Description

Returns the standardized Fourier coefficients determined in [stdCoefs](). Returns only values as set in the slot `filter`

Usage

```
getStdFourier(object)
```

Arguments

object   [shapeR]() object

Value

The standardized Fourier coefficients for all valid fish as determined by the slot `filter`

Author(s)

Lisa Anne Libungan

---

getStdMeasurements *Get simple shape variables after standardization, filtered according to filter*

Description

Returns the simple shape variables determined in `stdCoefs`. Returns only values as set in the slot `filter`

Usage

```
getStdMeasurements(object)
```

Arguments

object   [shapeR]() object

Value

A data frame with all valid fish as determined by the slot `filter`. Returns only variables that have not been removed after standardization.

Author(s)

Lisa Anne Libungan

Examples

```
data(shape)
#Calculate the mean standardized otolith length for each fish population
tapply(getStdMeasurements(shape)$otolith.length,
getMasterlist(shape)$pop,mean)
```

---

getStdWavelet   *Get standardized wavelet coefficients, filtered according to filter*

Description

Returns the standardized wavelet coefficients determined in stdCoefs. Returns only values as set in the slot filter

Usage

```
getStdWavelet(object)
```

Arguments

object   [shapeR](#) object

Value

The standardized wavelet coefficients for all valid fish as determined by the slot filter

Author(s)

Lisa Anne Libungan

---

getWavelet   *Get wavelet coefficients, filtered according to filter*

Description

Returns the wavelet coefficients determined in [generateShapeCoefficients](#). Returns only values as set in the slot filter

Usage

```
getWavelet(object)
```

Arguments

object [shapeR](#) object

Value

The wavelet coefficients for all valid fish as determined by the slot `filter`

Author(s)

Lisa Anne Libungan

---

outline.reconstruction.plot
Plot outline reconstruction

Description

Show graphs of the reconstruction using different number of levels of wavelet reconstruction and Fourier power using different number of Fourier harmonics. Uses the output from [estimate.outline.reconstruction](#)

Usage

```
outline.reconstruction.plot(outline.rec.list,ref.w.level=5,
                            ref.f.harmonics=12,max.num.harmonics=32,...)
```

Arguments

outline.rec.list
>   The output from [estimate.outline.reconstruction](#)

ref.w.level   Reference level for graphical purposes. The default is 5 as is the default of [shapeR](#).

ref.f.harmonics
>   Reference Fourier harmonize. The default is 12 as is the default in [shapeR](#).

max.num.harmonics
>   Maximum number of Fourier harmonics to be shown

...   Additional parameters to be passed to 'plot'

Value

None

Author(s)

Lisa Anne Libungan

Examples

```
## Not run: data(shape)
est.list = estimate.outline.reconstruction(shape)
outline.reconstruction.plot(est.list,panel.first = grid())
## End(Not run)
```

| plotFourier | *Mean and standard deviation of the Fourier coefficients* |

Description

The mean and standard deviation of the Fourier coefficients

Usage

```
plotFourier(object, coef.index=NULL,class.name=NULL,useStdcoef=FALSE, ...)
```

Arguments

object	shapeR object
coef.index	An index vector for which fourier coefficents to be shown. Default is NULL and all coefficients are shown.
class.name	Column name in master list for partitioning the data into groups and showing the ratio of variance among to the sum of variance among and variance within.
useStdcoef	Boolean saying if to use the standardized coefficients or not
...	Additional parameters to be passed to 'plot'

Value

None

Author(s)

Lisa Anne Libungan

Examples

```
data(shape)
shape = stdCoefs(shape,classes="pop","length_cm")
plotFourier(shape,class.name= "pop",useStdcoef=TRUE)
```

---

plotFourierShape   *Mean otolith shape based on Fourier reconstruction*

Description

A function for showing the mean otolith shape based on Fourier reconstruction

Usage

```
plotFourierShape(object, class.name, show.angle = FALSE,lty=1:5,col=1:6, ...)
```

Arguments

object	A [shapeR](#) object
class.name	A string as the column name in the master list
show.angle	If TRUE angles are shown on the plot
lty, col	Vector of line types and colors. Values are used cyclically.
...	Additional parameters to be passed to 'plot'

Value

None

Author(s)

Lisa Anne Libungan

References

Libungan LA and Palsson S (2015) ShapeR: An R Package to Study Otolith Shape Variation among Fish Populations. PLoS ONE 10(3): e0121102. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0121102

Examples

```
data(shape)
plotFourierShape(shape, "pop",show.angle = TRUE,lwd=2,lty=1)
```

---

plotWavelet   *Mean and standard deviation of the wavelet coefficients*

Description

The mean and standard deviation of tdhe wavelet coefficients

Usage

```
plotWavelet(object, level, start.angle = 0, class.name=NULL,useStdcoef=FALSE,...)
```

Arguments

object	A [shapeR](#) object
level	The wavelet level to be shown
start.angle	The angle in degrees, the x-axis should start on
class.name	Column name in master list for partitioning the data into groups and showing the ratio of variation among groups.
useStdcoef	Choose "TRUE" or "FALSE" if coefficients should be standardized or not
...	Additional parameters to be passed to 'plot'

Value

None

Author(s)

Lisa Anne Libungan

Examples

```
data(shape)
shape = stdCoefs(shape,classes="pop","length_cm")
plotWavelet(shape,level=5,class.name= "pop",useStdcoef=TRUE)
```

---

plotWaveletShape   *Mean otolith shape based on wavelet reconstruction*

Description

A function for showing the mean otolith shape based on wavelet reconstruction

Usage

```
plotWaveletShape(object, class.name,show.angle=FALSE,lty=1:5,col=1:6,...)
```

Arguments

object	A [shapeR](#) object
class.name	A string as the column name in the master list
show.angle	If TRUE angles are shown on the plot
lty, col	Vector of line types and colors. Values are used cyclically.
...	Additional parameters to be passed to 'plot'

Value

None

Author(s)

Lisa Anne Libungan

References

Nason, G. (2012) [wavethresh](#): Wavelets statistics and transforms, version 4.5. R package.

Examples

```
data(shape)
plotWaveletShape(shape, "pop",show.angle = TRUE,lwd=2,lty=1)
```

---

read.master.list   *Read updated master list*

Description

Reads an updated master list. This is important to run if you want to ensure that a updated master list is used in the analysis.

Usage

```
read.master.list(object, ...)
```

Arguments

object	A shapeR object
...	Additional parameter for read.csv for reading the info.file

Value

shapeR object with values in slots:

- master.list.org

Author(s)

Lisa Anne Libungan

---

remove.outline   *Remove otolith outline*

Description

A function for removing an otolith outline from the file 'outline.list'. Typically done if the image is of bad quality and needs to be enhanced in a image processing software

Usage

```
remove.outline(object, folder = "", fname = "")
```

Arguments

object	A shapeR object
folder	The folder name where the outline that needs to be removed is stored
fname	The file name of the outline to be removed

Value

[shapeR](#) object

Author(s)

Lisa Anne Libungan

References

Libungan LA and Palsson S (2015) ShapeR: An R Package to Study Otolith Shape Variation among Fish Populations. PLoS ONE 10(3): e0121102. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0121102

Examples

```
## Not run:
#Use test data from example in Libungan and Palsson (2015):
shape = shapeR("ShapeAnalysis/","FISH.csv")
shape = detect.outline(shape)
#If otolith outline in folder IC named 403_1 needs to be removed
shape = remove.outline(shape, "IC", "403_1")
## End(Not run)
```

---

setFilter	*Set a filter to analyze the shape data*

Description

Sets a filter on master.list. Here it is possible to filter the master.list by specific ages, maturity stages, areas, etc. If no value is set, all data with shape parameters are used

Usage

```
setFilter(object, filter)
```

Arguments

object	A [shapeR](#) object
filter	A vector restricting the new filter value. Only otoliths having shape parameters are selected.

Value

A [shapeR](#) object with the slot filter set.

Author(s)

Lisa Anne Libungan

Examples

```
data(shape)
#Filter only Icelandic and Norwegian samples
shape = setFilter(shape,
getMasterlist(shape, useFilter = FALSE)$pop %in% c("NO","IC"))
table(getMasterlist(shape)$pop)
#Reset filter
shape = setFilter(shape)
table(getMasterlist(shape)$pop)
```

---

shape   *An example shapeR instance including 160 images.*

Description

The shape coefficients have been generated. The wavelet coefficients have been standardized using pop and length_cm.

Usage

```
data(shape)
```

Format

A shapeR class including 160 images

Details

The class slot's are as follows:

- project.path. A path as "ShapeAnalysis/"
- info.file. A file as FISH.csv. The information is stored in the data frame master.list
- outline.list. A list with three elements (IC, NO, SC) which give a list of the otolith outlines
- filter. A logical vector showing which elements of the master list have valid otoliths
- fourier.coef. A matrix of the Normalized Elliptic Fourier coefficients
- wavelet.coef. A matrix of the wavelet coefficients
- shape. A matrix of shape variables after scaling according to calibration otolith.area, otolith.length, otolith.width, otolith.perimeter.
- fourier.coef.std. A matrix which will contain standardized Fourier coefficients
- wavelet.coef.std. A matrix which will contain standardized wavelet coefficients
- shape.coef.raw. A matrix of shape variables before scaling according to calibration otolith.area, otolith.length, otolith.width, otolith.perimeter.
- master.list. The contents of the info.file

Source

<https://github.com/lisalibungan/shapeR>

---

shapeR *shapeR*

Description

Collection and analysis of otolith shape data

a shapeR class

Usage

```
shapeR(project.path, info.file, ...)
```

Arguments

project.path	The base project path where the images are stored
info.file	The information file which store the information on the fish and otoliths. This is the base for the master.list
...	Additional parameters to be passed to 'read.csv' for reading the info.file

Value

a [shapeR](#) object

Slots

project.path Path to the project where the images are stored

info.file Info file containing fish and otolith information

master.list.org The contents of the info.file

master.list The contents of the info.file with added shape parameters and descriptors

outline.list.org A list of all the original otolith outlines

outline.list A list of all the otolith outlines. It returns a list of smoothed if contour smoothing (usingsmoothout) has been conducted.

filter A logical vector selecting the otoliths used for analysis

wavelet.coef.raw The wavelet coefficients for all the otolith outlines

wavelet.coef The wavelet coefficients after aligning with the info.file. The data is generated when [enrich.master.list](#) is run

wavelet.coef.std The standardized wavelet coefficients. The data is generated when [stdCoefs](#) is run

wavelet.coef.std.removed The index of the removed wavelet coefficients after standardization. The data is generated when [stdCoefs](#) is run

fourier.coef.raw The Fourier coefficients for all the otolith outlines

fourier.coef The Fourier coefficients for after aligning with the info file. The data is generated when [enrich.master.list](#) is run

fourier.coef.std The standardized Fourier coefficients. The data is generated when [stdCoefs](#) is run

fourier.coef.std.removed The index of the removed Fourier coefficents after standardization. The data is generated when [stdCoefs](#) is run

shape.coef.raw The uncalibrated shape measurements for all the otoliths. The shape parameters are: otolith.area, otolith.length, otolith.width, otolith.perimeter

shape.coef The shape measurements for after aligning with the info file. The shape parameters have been calibrated using the calibration parameter as registered in the datafile as the column 'cal'.

shape.std The standardized shape measurements. The data is generated when [stdCoefs](#) is run

shape.std.removed The index of the removed shape measurements after standardization. The data is generated when [stdCoefs](#) is run

Author(s)

Lisa Anne Libungan & Snaebjorn Palsson

References

Libungan LA and Palsson S (2015) ShapeR: An R Package to Study Otolith Shape Variation among Fish Populations. PLoS ONE 10(3): e0121102. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0121102

See Also

https://github.com/lisalibungan/shapeR

[plotWavelet](#)

[plotFourier](#)

[plotWaveletShape](#)

[plotFourierShape](#)

[capscale](#)

[cluster.plot](#)

[setFilter](#)

[lda](#)

[detect.outline](#)

[generateShapeCoefficients](#)

[enrich.master.list](#)

Examples

```
## Not run:

# This example has two sections: (1) Demonstration of how a shapeR object
# is analyzed and (2) How to create a shapeR object from an archive of
# image files.
```

```
#---------------------------------------
# Section 1: Analyzing a shapeR object

data(shape)

#Standardize coefficients
shape = stdCoefs(shape,"pop","length_cm")

#Visualize Wavelet and Fourier coefficients
plotWavelet(shape,level=5,class.name= "pop",useStdcoef=TRUE)
plotFourier(shape,class.name= "pop",useStdcoef=TRUE)

#Examine the mean shapes
plotWaveletShape(shape, "pop",show.angle = TRUE,lwd=2,lty=1)
plotFourierShape(shape, "pop",show.angle = TRUE,lwd=2,lty=1)

#Canonical analysis
library(vegan)
cap.res = capscale(getStdWavelet(shape) ~ getMasterlist(shape)$pop)
anova(cap.res)

#Visualize the canonical scores
eig=eigenvals(cap.res,constrained=TRUE)
eig.ratio = eig/sum(eig)

cluster.plot(scores(cap.res)$sites[,1:2],getMasterlist(shape)$pop
,plotCI=TRUE
,xlab=paste("CAP1 (",round(eig.ratio[1]*100,1),"%)",sep="")
,ylab=paste("CAP2 (",round(eig.ratio[2]*100,1),"%)",sep="")
,main="Canonical clustering"
)

#Only analyze Icelandic and Norwegian samples
shape = setFilter(shape, getMasterlist(shape, useFilter = FALSE)$pop %in% c("NO","IC"))

#Classifier on standardized wavelet
lda.res.w = lda(getStdWavelet(shape),getMasterlist(shape)$pop,CV=TRUE)
ct.w = table(getMasterlist(shape)$pop,lda.res.w$class)

diag(prop.table(ct.w, 1))

# Total percent correct
sum(diag(prop.table(ct.w)))

cap.res = capscale(getStdWavelet(shape) ~ getMasterlist(shape)$pop)
anova(cap.res)

#Classifier on canoncial values
lda.res.w = lda(scores(cap.res)$sites,getMasterlist(shape)$pop,CV=TRUE)
ct.w = table(getMasterlist(shape)$pop,lda.res.w$class)

diag(prop.table(ct.w, 1))
```

```
# Total percent correct
sum(diag(prop.table(ct.w)))

#----------------------------------------
# Section 2: Creating a shapeR object from image files

# The following example requires the user to download an archive of JPEG
# files from https://github.com/lisalibungan/shapeR/
# place the ShapeAnalysis directory inside the working directory.

shape = shapeR("~/ShapeAnalysis/","FISH.csv")
shape = detect.outline(shape,write.outline.w.org = TRUE)

shape = generateShapeCoefficients(shape)
shape = enrich.master.list(shape)

## End(Not run)
```

---

show,shapeR-method   *Show a shapeR object*

Description

Show the project.path and info.file, the number of outlines that have been read and which fundamental methods have been run.

Usage

```
## S4 method for signature 'shapeR'
show(object)
```

Arguments

object   a shapeR oject

Value

None

show.original.with.outline

Show the extracted outline on top of the original image

Description

A function which displays the outlines which were extracted from the image in the "Fixed" folder on top of the corresponding image in the "Original" folder.

Usage

```
show.original.with.outline(object, folder, fname)
```

Arguments

object	A [shapeR](#) object
folder	The folder name where the image is stored
fname	Image file name. Not including the extension ".jpg"

Value

None

Author(s)

Lisa Anne Libungan

References

Libungan LA and Palsson S (2015) ShapeR: An R Package to Study Otolith Shape Variation among Fish Populations. PLoS ONE 10(3): e0121102. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0121102

Examples

```
## Not run:
#Follow the example in Libungan and Palsson (2015) and run the following lines:
show.original.with.outline(shape,"IC","403_2")
## End(Not run)
```

---

smoothout   *Contour smoothing*

Description

Remove high frequency pixel noise around the otolith outline

Usage

```
smoothout(object, n)
```

Arguments

object	A [shapeR](#) object
n	The number of iterations. The default value is 100.

Value

A [shapeR](#) object with smoothed otolith outlines in the slot outline.list

Author(s)

Lisa Anne Libungan

References

Haines, A.J., Crampton, J.S. (2000). Improvements to the method of Fourier shape analysis as applied in morphometric studies. Palaeontology 43: 765-783.

Claude, J. (2008) Morphometrics with R. Springer. 316 p.

Examples

```
data(shape)
shape = smoothout(shape,n=100)

# Plot smoothed outline on top of original outline for comparison
outline.org=shape@outline.list.org[["IC"]][["403_2"]]
outline=shape@outline.list[["IC"]][["403_2"]]
plot(outline.org$X,outline.org$Y,type='l',xlab="",ylab="",lwd=2,axes=FALSE)
lines(outline$X,outline$Y,col="red",lwd=2)
legend("bottomleft",c('Original','Smoothed'),lty=1,col=c('black','red'),lwd=2)
```

---

stdCoefs   *Standardize coefficients*

Description

Function to standardized the wavelet and Fourier coefficients for a specific parameter such as the fish length. For each country/population a regression coefficient is calculated as a function of fish length. If the slope is significantly different from zero, a correction is made according to Lleonart et al 2000. First ANCOVA is performed: variable ~ pop*length_cm, following a method by Longmore et al 2010. If there is a significant interaction between population and length_cm, then the coefficients are not used and automatically discarded. If there is no interaction, the coefficients are kept and standardized with regards to fish length.

Usage

```
stdCoefs(object, classes=NA, std.by, std.type = "mean", p.crit = 0.05,bonferroni= FALSE)
```

Arguments

object	A [shapeR](#) object
classes	The classes to be grouped for standardization. Should be the same as used for the statistical tests
std.by	The parameter to be used for standardization. Typically the length of the fish from the master.list.
std.type	The tuning of the standardization. The standardization can be sensitive to what value all the fishes are standardized to. Possible values are:

- min Standardized as the minimum value of std.by
- mean Standardized as the mean value of std.by
- max Standardized as the maximum value of std.by

p.crit	An argument used to select the threshold critera for omitting coefficients which show interaction with fish length. If p.crit = 0.05, all coefficients which have p<0.05 are omitted. If p.crit = 0.01, only coefficients with p<0.01 are omitted.
bonferroni	A logical parameter for performing Bonferroni for multiple testing

Value

A [shapeR](#) object with standardized shape coefficients in the slot shape.std

Author(s)

Lisa Anne Libungan

References

Lleonart, J., Salat, J. & Torres, G.J. (2000) Removing allometric effects of body size in morphological analysis. Journal of Theoretical Biology, 205, 85-93.

Longmore, C., Fogarty, K., Neat, F., Brophy, D., Trueman, C., Milton, A. & Mariani, S. (2010) A comparison of otolith microchemistry and otolith shape analysis for the study of spatial variation in a deep-sea teleost, *Coryphaenoides rupestris*. Environmental Biology of Fishes, 89, 591-605.

Reist, J.D. (1985) An Empirical-Evaluation of Several Univariate Methods That Adjust for Size Variation in Morphometric Data. Canadian Journal of Zoology-Revue Canadienne De Zoologie, 63, 1429-1439.

Examples

```
data(shape)
shape = stdCoefs(shape,classes="pop","length_cm")
```

---

write.image.with.outline

Write outlines on top of the original images for quality checking

---

Description

A function which writes the outlines which were extracted from the images in the folder "Fixed" on top of the corresponding images in the "Original" folder. Viewing the resulted images in the folder "Original_with_outlines" is a good quality check to ensure the correct outline has been extracted. If the outline is not correct, then the image can be fixed in an image software, such as GIMP (www.gimp.org), placed in the "Fixed" folder and then the detect.outline step is repeated. The function [detect.outline](#) calls this function if the parameter write.outline.w.org is set to TRUE.

Usage

```
write.image.with.outline(object, folder = NA, fname = NA, doProgress = TRUE)
```

Arguments

object	A [shapeR](#) object
folder	The folder name where the image is stored
fname	Image file name. Not including the extension ".jpg"
doProgress	If TRUE, a progressbar is shown

Value

None

Author(s)

Lisa Anne Libungan

References

Libungan LA and Palsson S (2015) ShapeR: An R Package to Study Otolith Shape Variation among Fish Populations. PLoS ONE 10(3): e0121102. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0121102

Examples

```
## Not run:
#Use test data from Libungan and Palsson (2015) and run the following lines:
shape = shapeR("ShapeAnalysis/","FISH.csv")
shape = detect.outline(shape,write.outline.w.org = FALSE)
write.image.with.outline(shape)
## End(Not run)
```

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