

Package ‘RvtkStatismo’

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Type Package

Title Integrates statismo and R using the vtkStandardMeshRepresenter

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Description Integrates statismo and R using the vtkStandardMeshRepresenter.
Statismo shape models will be stored as objects of class ``pPCA". (this is work in progress).

License GPL >=2

Imports Rcpp (>= 0.11.1),Morpho,Rvcg

LinkingTo Rcpp,RcppEigen

SystemRequirement VTK5.8, statismo (>= 0.9 best ist freshly from github)

URL <http://github.com/zarquon42b/RvtkStatismo>, URL:
<http://github.com/statismo/statismo>

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Rvtk-package	<i>Integrates statismo and R using the vtkStandardMeshRepresente</i>
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Description

Integrates statismo and R using the vtkStandardMeshRepresenter. Statismo shape models will be stored as objects of class "pPCA". (this is work in progress).

Details

Package: RvtkStatismo
Type: Package
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Author(s)

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References

To be announced

getCoordVar	<i>get per coordinate variance from a statistical model</i>
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Description

get per coordinate variance from a statistical model

Usage

getCoordVar(model)

Arguments

model object of class pPCA

Note

calculates the per-coordinate variance as described in Luethi(2009)

References

Lüthi M, Albrecht T, Vetter T. 2009. Probabilistic modeling and visualization of the flexibility in morphable models. In: Mathematics of Surfaces XIII. Springer. p 251-264

getDataLikelihood	<i>calculate probability/coefficients for a matrix/mesh given a statistical model</i>
-------------------	---

Description

calculate probability for a matrix/mesh given a statistical model

Usage

```
getDataLikelihood(x, model, align = FALSE, use.lm)

## S3 method for class 'matrix'
getDataLikelihood(x, model, align = FALSE, use.lm = NULL)

## S3 method for class 'mesh3d'
getDataLikelihood(x, model, align = FALSE, use.lm = NULL)

getCoefficients(x, model, align = TRUE, use.lm = NULL)
```

Arguments

x	matrix or mesh3d
model	a model of class pPCA
align	logical: if TRUE the data will be aligned to the model's mean
use.lm	integer vector specifying row indices of the coordinates to use for rigid registration on the model's meanshape.

Value

getProb returns a probability, while getCoefficients returns the (scaled) scores in the pPCA space.

mesh2vtp	<i>exports a triangular mesh of class mesh3d to a vtp file</i>
----------	--

Description

exports a triangular mesh of class mesh3d to a vtp file

Usage

```
mesh2vtp(mesh, filename = dataname)
```

Arguments

mesh	mesh of class mesh3d
filename	character

meshalign	<i>align meshes stored in a list by their vertices</i>
-----------	--

Description

align meshes stored in a list by their vertices

Usage

```
meshalign(meshlist, scale = TRUE, array = FALSE)
```

Arguments

meshlist	list containing triangular meshes of class "mesh3d"
scale	logical: request scaling during alignment
array	logical: if TRUE the superimposed vertices will be returned as 3D array.

Value

returns a list of aligned meshes or an array of dimensions $k \times 3 \times n$, where k =number of vertices and n =sample size.

meshlist2array	<i>convert meshes to array consisting of vertex coordinates</i>
----------------	---

Description

convert meshes to array consisting of vertex coordinates

Usage

```
meshlist2array(meshlist)
```

Arguments

meshlist list containing triangular meshes of class "mesh3d"

Value

returns an array with k x 3 x n dimensions where k=number of vertices, and n=sample size.

pPCA/pPCAconstr	<i>calculate or modify a probabilistic PCA based on 3D-coordinates</i>
-----------------	--

Description

calculate or modify a probabilistic PCA based on 3D-coordinates

Usage

```
pPCA(array, align = TRUE, sigma = NULL, exVar = 1, scale = TRUE,
      representer = NULL)
```

```
pPCAconstr(array, align = TRUE, missingIndex, deselect = FALSE,
            sigma = NULL, exVar = 1, representer = NULL, scale = TRUE,
            fullfit = FALSE)
```

```
setMod(procMod, sigma, exVar)
```

```
## S3 method for class 'pPCA'
setMod(procMod, sigma = NULL, exVar = 1)
```

```
## S3 method for class 'pPCAconstr'
setMod(procMod, sigma = NULL, exVar = 1)
```

Arguments

array	array of dimensions $k \times 3 \times n$, where k =number of coordinates and n =sample size.
align	logical: if TRUE, the data will be aligned first
missingIndex	integer vector: specifies which points are missing in the constrained model
deselect	logical: if TRUE, missingIndex references the existing coordinates instead of the missing ones.
procMod	object of class "pPCA" or "pPCAconstr"
sigma	estimate of error variance (sensible is a value estimating coordinate error in terms of observer error)
exVar	numeric value with $0 < \text{exVar} \leq 1$ specifying the PCs to be included by their cumulative explained Variance
representer	a triangular mesh, where the vertices correspond to the coordinates in array, leave NULL for pointclouds.
scale	logical: allow scaling in Procrustes fitting
fullfit	logical: if FALSE only the non-missing points will be used for registration.

Value

pPCA and pPCAconstr return a probabilistic PCA model of class "pPCA" or "pPCAconstr" respectively. predictPCA and predictPCAcond select the most probable shape within a given model (within defined boundaries), setMod is used to modify existing models by changing sigma and exVar.

The class "pPCA" is a list containing the following items (still not yet set in stone)

PCA	a list containing <ul style="list-style-type: none"> • sdev: the square roots of the covariance matrix' eigenvalues • rotation: matrix containing the orthonormal PCBasis vectors • x: the scores within the latent space(scaled by 1/sdev) • center: a vector of the mean shape in with coordinates ordered (x1,y1,z1, x2, y2,z2, ..., xn,yn,zn)
scale	logical: indicating if the data was aligned including scaling
representer	an object of class mesh3d or a list with entry vb being a matrix with the columns containing coordinates and it a 0x0 matrix
sigma	the noise estimation of the data
Variance	a data.frame containing the Variance, cumulative Variance and Variance explained by each Principal component
rawdata	optional data: a matrix with rows containing the mean centred coordinates in order (x1,y1,z1, x2, y2,z2, ..., xn,yn,zn)

References

Lüthi M, Albrecht T, Vetter T. 2009. Probabilistic modeling and visualization of the flexibility in morphable models. In: Mathematics of Surfaces XIII. Springer. p 251-264

Examples

```

require(Morpho)
data(boneData)
model <- pPCAconstr(boneLM[,-1],missingIndex=3:4)
## change parameters without recomputing Procrustes fit
model1 <- setMod(model, sigma=1, exVar=0.8)
## predict the left out shape from the constrained model
boneLM1 <- predictpPCAconstr(boneLM[-c(3:4),,1],model)
## Not run:
##visualize prediction error
deformGrid3d(boneLM1,boneLM[, ,1],ngrid=0)

## End(Not run)

```

predictpPCA/predictpPCAconstr

predict or restrict a mesh or matrix based on a statistical model

Description

predict or restrict a mesh or matrix based on a statistical model

Usage

```

predictpPCAconstr(x, model, representer, origSpace = TRUE, pPCA = FALSE,
  ...)

## S3 method for class 'matrix'
predictpPCAconstr(x, model, representer = TRUE,
  origSpace = TRUE, pPCA = FALSE, ...)

## S3 method for class 'mesh3d'
predictpPCAconstr(x, model, representer = TRUE, sdmax,
  origSpace = TRUE, pPCA = FALSE, ...)

predictpPCA(x, model, representer = TRUE, ...)

## S3 method for class 'matrix'
predictpPCA(x, model, representer = TRUE, origSpace = TRUE,
  use.lm = NULL, sdmax, mahaprob = c("none", "chisq", "dist"),
  align = TRUE, ...)

## S3 method for class 'mesh3d'
predictpPCA(x, model, representer = TRUE, origSpace = TRUE,
  use.lm = NULL, sdmax, mahaprob = c("none", "chisq", "dist"),
  align = TRUE, ...)

```

```
## S3 method for class 'numeric'
predictpPCA(x, model, representer = TRUE, ...)
```

Arguments

<code>x</code>	a matrix, a mesh3d or a vector (for pPCA models) containing standardized variables within the PC-space
<code>model</code>	model of class pPCA or pPCAconstr
<code>representer</code>	if TRUE and the model contains a representer mesh, a surface mesh will be returned, coordinate matrix otherwise.
<code>origSpace</code>	logical: rotate the estimation back into the original coordinate system.
<code>pPCA</code>	logical: if TRUE, a constrained pPCA model is returned. "chisq" uses the Chi-Square distribution of the squared Mahalanobisdistance, while "dist" restricts the values to be within a multi-dimensional sphere of radius sdmax. If FALSE the probability will be determined per PC separately.
<code>use.lm</code>	optional: integer vector specifying row indices of the coordinates to use for rigid registration on the model's meanshape.
<code>sdmax</code>	maximum allowed standard deviation (per Principal axis) within the model space. Defines the probabilistic boundaries.
<code>mahaprob</code>	character: if != "none", use mahalanobis-distance to determine overall probability (of the shape projected into the model space).

Value

`predictpPCA` returns a matrix/mesh3d restricted to the boundaries given by the modelspace.

`predictpPCAconstr` returns a list with

<code>estim</code>	matrix/mesh3d representing the mean of the restricted space
<code>pPCA</code>	if <code>pPCA = TRUE</code> a pPCA model representing the gaussian subspace given the constraints is returned
<code>rot</code>	the transformation of <code>x</code> into the modelspace that can be reverted by calling <code>rotreverse</code> from the package Morpho

<code>read.vtk</code>	<i>imports vtk and vtp files</i>
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Description

imports vtk and vtp files

Usage

```
read.vtk(filename)
```


Arguments

filename character string

Value

list of class mesh3d

rigidAlign	<i>Fast Procrustes align of coordinates</i>
------------	---

Description

Fast Procrustes align of coordinates

Usage

```
rigidAlign(array, scale = TRUE, missingIndex, deselect = FALSE)
```

Arguments

array	array of coordinates
scale	logical: request scaling during alignment
missingIndex	integer vector: specifies which points are missing (for building constrained model)
deselect	logical: if TRUE, missingIndex references the existing coordinates instead of the missing ones.

Value

a list containing

rotated	array containing registered coordinates
mshape	matrix containing meanshape

statismoBuildModel	<i>generate a statistical model using an array of superimposed landmarks or a list of meshes</i>
--------------------	--

Description

generate a statistical model using an array of superimposed landmarks

Usage

```
statismoBuildModel(x, representer, sigma = 0, scale = TRUE)
```

Arguments

x	array of aligned 3D-coordinates or a list of aligned registered meshes.
representer	matrix or triangular mesh of class "mesh3d" with vertices corresponding to rows in the array.
sigma	noise in the data
scale	logical: set to TRUE, if scaling was involved in the registration.

Value

an object of class [pPCA](#)

See Also

[pPCA](#)

Examples

```
require(Morpho)
data(boneData)
align <- rigidAlign(boneLM)$rotated
mymod <- statismoBuildModel(align, representer=align[, , 1], sigma=2, scale=TRUE)
## save it
statismoSaveModel(mymod, "mymod.h5")
```

statismoGPmodel	<i>expands a models variability by adding a Gaussian kernel function</i>
-----------------	--

Description

expands a models variability by adding a Gaussian kernel function to the empiric covariance matrix and builds a low-rank approximation of the resulting PCA

Usage

```
statismoGPmodel(model, useEmpiric = TRUE, kernel = list(c(100, 70)),
  ncomp = 10, nystroem = 500)
```

Arguments

model	shape model of class pPCA
useEmpiric	logical: if TRUE, the empiric covariance kernel will be added to the Gaussian ones.
kernel	a list containing two valued vectors containing with the first entry specifying the bandwidth and the second the scaling of the Gaussian kernels.
ncomp	integer: number of PCs to approximate
nystroem	number of samples to compute Nystroem approximation of eigenvectors

Value

returns a shape model of class [pPCA](#)

See Also

[pPCA](#)

Examples

```
### this is a silly example with only 10 landmarks
require(Morpho)
data(boneData)
align <- rigidAlign(boneLM)$rotated
mod <- statismoBuildModel(align)
GPmod <- statismoGPmodel(mod,kernel=list(c(10,1),c(1,1)))##extend flexibility using two Gaussian kernels
GPmodNoEmp <- statismoGPmodel(mod,kernel=list(c(10,1),c(1,1)),useEmpiric = FALSE)##extend flexibility using two
PC1orig <- predictpPCA(2,mod)# get shape in 2sd of first PC of original model
PC1 <- predictpPCA(2,GPmod)# get shape in 2sd of first PC of the extended model
PC1NoEmp <- predictpPCA(2,GPmodNoEmp)# get shape in 2sd of first PC
##visualize the differences from the mean (green spheres)
deformGrid3d(PC1,GPmod$mshape,ngrid=0)##
deformGrid3d(PC1NoEmp,GPmod$mshape,ngrid=0,col1=4,add=TRUE)##only deviates in 5 landmarks from the mean (dark bl
deformGrid3d(PC1orig,GPmod$mshape,ngrid=0,col1=5,add=TRUE)
```

statismoLoadModel/statismoSaveModel

save and load a statistical model of class pPCA to statismo hdf5 format

Description

save and load a statistical model of class pPCA to statismo hdf5 format

Usage

```
statismoSaveModel(model, modelname = dataname)
```

```
statismoLoadModel(modelname, scale = TRUE)
```

Arguments

model	object of class pPCA
modelname	filename to read/save

Value

statismoLoadModel returns an object of class [pPCA](#) while statismoSaveModel saves an object of class [pPCA](#) to disk in the statismo file format.

See Also

[pPCA](#)

StatismoModelMembers *Implementation/Emulation of the statsimo StatisticalModel class.*

Description

Implementation/Emulation of the statsimo StatisticalModel class.

Usage

```
GetPCABasisMatrix(model)
```

```
GetOrthonormalPCABasisMatrix(model)
```

```
GetNoiseVariance(model)
```

```
GetMeanVector(model)
```

```
GetPCAVarianceVector(model)

ComputeLogProbabilityOfDataset(model, dataset)

ComputeProbabilityOfDataset(model, dataset)

DrawMean(model)

ComputeCoefficientsForDataset(model, dataset)
```

Arguments

model	object of class <code>pPCA</code>
dataset	an (already aligned) mesh or $k \times 3$ matrix containing the datasets coordinates.

Details

see http://statismo.github.io/statismo/classdoc/html/classstatismo_1_1StatisticalModel.html for details.

Value

functions return matrices, (log)-probabilities or coefficients for specific dataset

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