

Package ‘FUNTA’

April 1, 2016

Type Package

Title Functional Tangential Angle Pseudo-Depth

Version 0.1.0

Author Andre Rehage

Maintainer Andre Rehage <rehage@statistik.tu-dortmund.de>

Description Computes the functional tangential angle pseudo-depth and its robustified version from the paper by Kuhnt and Rehage (2016). See Kuhnt, S.; Rehage, A. (2016): An angle-based multivariate functional pseudo-depth for shape outlier detection, JMVA 146, 325-340, <doi:10.1016/j.jmva.2015.10.016> for details.

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LazyData TRUE

RoxygenNote 5.0.1

NeedsCompilation no

Repository CRAN

Date/Publication 2016-04-01 14:33:13

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FUNTA-package	<i>Obtain FUNTA and rFUNTA pseudo-depth for a given functional dataset</i>
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Description

Given the discretized functional observations, the functions FUNTA and rFUNTA are able to compute the functional tangential angle pseudo-depths as introduced in Kuhnt and Rehage (2016).

Details

For FUNTA and rFUNTA, insert the data in matrix form (n by T, where n is the number of observations and T is the number of time points).

Author(s)

A. Rehage.

References

Kuhnt, S.; Rehage, A. (2016) An angle-based multivariate functional pseudo-depth for shape outlier detection. *Journal of Multivariate Analysis* 146, 325-340.

Examples

```
x <- seq(0, 2*pi, by = 0.01)
y1 <- sin(x)
y2 <- sin(1.02*x)
y3 <- cos(x)
y <- rbind(y1, y2, y3)
FUNTA(y, tick.dist = 0.01)
rFUNTA(y, tick.dist = 0.01)
```

angle	<i>Auxiliary function to compute intersection angles</i>
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Description

Internal function that is used by FUNTA and rFUNTA.

Usage

```
angle(cut.slope, ref.slope, tick.dist)
```

Arguments

<code>cut.slope</code>	The slope of function x1.
<code>ref.slope</code>	The slope of function x2.
<code>tick.dist</code>	The length of the slopes.

Value

The intersection angle of x1 and x2.

Author(s)

A. Rehage

Examples

```
angle(1,2,0.1)
```

FUNTA

Obtain FUNTA pseudo-depth values

Description

For a given dataset, FUNTA pseudo-depth values can be obtained. FUNTA is a functional data depth that is based on the intersection angles that the centered functions form with each other.

Usage

```
FUNTA(Data, centered = FALSE, give.angles = FALSE, tick.dist = 1)
```

Arguments

<code>Data</code>	a matrix. Enter the discretized values of a functional data set in a n times T matrix, where n is the number of functional observations and T is the number of time points.
<code>centered</code>	boolean. If the data are already centered, that means, the mean of each row of Data is 0, this can be set to TRUE to save computation time. Default value is FALSE.
<code>give.angles</code>	boolean. If the intersection angles of each function with the other functions are to be displayed, set to TRUE. Default value is FALSE.
<code>tick.dist</code>	atomic vector. The distance between two neighbored time points can be set here. Default value is 1.

Details

The larger the value of FUNTA is, the less it can be regarded as a shape outlier, and vice versa. The values are bounded by 0 and 1.

Value

If `give.angles = TRUE`, a list of two elements FUNTA and Angles. Otherwise only the first element of that list is returned.

FUNTA	Vector of FUNTA values. First row of Data corresponds to first element of FUNTA.
Angles	List of intersection angles. First element of list corresponds to the intersection angles that the first row of Data has with every other row of Data, ordered by time point of intersection.

Author(s)

A. Rehage

References

Kuhnt, S.; Rehage, A. (2016) An angle-based multivariate functional pseudo-depth for shape outlier detection. *Journal of Multivariate Analysis* 146, 325-340.

Examples

```
x <- seq(0, 2*pi, by = 0.01)
y1 <- sin(x)
y2 <- sin(1.02*x)
y3 <- cos(x)
y <- rbind(y1, y2, y3)
FUNTA(y, tick.dist = 0.01)
```

rFUNTA

Obtain rFUNTA pseudo-depth values

Description

For a given dataset, rFUNTA pseudo-depth values can be obtained. rFUNTA is a robustified functional data depth that is based on the intersection angles that the centered functions form with each other.

Usage

```
rFUNTA(Data, centered = FALSE, type.inner = "max", type.outer = "median", tick.dist = 1,
nObs = nrow(Data))
```

Arguments

Data	a matrix. Enter the discretized values of a functional data set in a n times T matrix, where n is the number of functional observations and T is the number of time points.
centered	boolean. If the data are already centered, that means, the mean of each row of Data is 0, this can be set to TRUE to save computation time. Default value is FALSE.
type.inner	One of "max" (default), "median", "mean". Note that only the default setting produces rFUNTA values as introduced in Kuhnt and Rehage (2016). The other options can be used if not the maximum intersection angle of each pair of functions is of interest, but the median or mean intersection angle.
type.outer	One of "max", "median" (default), "mean". Note that only the default setting produces rFUNTA values as introduced in Kuhnt and Rehage (2016). The other options can be used if not the <i>median</i> value of the $n-1$ weighted intersection angles of each function is of interest, but the maximum or mean of it.
tick.dist	atomic vector. The distance between two neighbored time points can be set here. Default value is 1.
nObs	atomic vector. If the dataset has more than one dimension, specify nObs with the number of observations per dimension. Data then has to be in the style of <code>rbind(Dim1, Dim2, ...)</code> . Note that tick.dist has to be equal for all the dimensions.

Details

The larger the value of FUNTA is, the less it can be regarded as a shape outlier, and vice versa. The values are bounded by 0 and 1.

Value

Vector of rFUNTA values. First observation in Data corresponds to first element of FUNTA.

Author(s)

A. Rehage

References

Kuhnt, S.; Rehage, A. (2016) An angle-based multivariate functional pseudo-depth for shape outlier detection. *Journal of Multivariate Analysis* 146, 325-340.

Examples

```
x <- seq(0, 2*pi, by = 0.01)
y1 <- sin(x)
y2 <- sin(1.02*x)
y3 <- cos(x)
y <- rbind(y1, y2, y3)
rFUNTA(y, tick.dist = 0.01)
```

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