Package 'hdftsa'

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Maintainer Han Lin Shang <hanlin.shang@mq.edu.au>

Description Offers methods for visualizing, modelling, and forecasting high-dimensional functional time series, also known as functional panel data. Documentation about 'hdftsa' is provided via the paper by Cristian F. Jimenez-Varon, Ying Sun and Han Lin Shang (2024, <doi:10.1080/10618600.2024.2319166>).

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Author Han Lin Shang [aut, cre] (ORCID: <https://orcid.org/0000-0003-1769-6430>)

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hdftsa-package *High-dimensional Functional Time Series Analysis*

Description

Offers methods for visualizing, modelling, and forecasting high-dimensional functional time series, also known as functional panel data. Documentation about 'hdftsa' is provided via the paper by Cristian F. Jimenez-Varon, Ying Sun and Han Lin Shang (2024, <doi:10.1080/10618600.2024.2319166>).

Author(s)

Han Lin Shang [aut, cre] (<https://orcid.org/0000-0003-1769-6430>)

Maintainer: Han Lin Shang <hanlin.shang@mq.edu.au>

References

C. F. Jimenez-Varon, Y. Sun and H. L. Shang (2024) Forecasting high-dimensional functional time series: Application to sub-national age-specific mortality, *Journal of Computational and Graphical Statistics*, **33**(4), 1160-1174.

C. F. Jimenez-Varon, Y. Sun and H. L. Shang (2024) Forecasting density-valued functional panel data, *Australian and New Zealand Journal of Statistics*, under minor revision.

FANOVA *Functional analysis of variance fitted by means.*

Description

Decomposition by functional analysis of variance fitted by means.

Usage

```
FANOVA(data_pop1, data_pop2, year=1959:2020, age= 0:100,
       n_prefectures=51, n_populations=2)
```

Arguments

data_pop1	It's a p by n matrix
data_pop2	It's a p by n matrix
year	Vector with the years considered in each population.
n_prefectures	Number of prefectures
age	Vector with the ages considered in each year.
n_populations	Number of populations.

Value

FGE_mean	FGE_mean, a vector of dimension p
FRE_mean	FRE_mean, a matrix of dimension length(row_partition_index) by p.
FCE_mean	FCE_mean, a matrix of dimension length(column_partition_index) by p.

Author(s)

Cristian Felipe Jimenez Varon, Ying Sun, Han Lin Shang

References

C. F. Jimenez Varon, Y. Sun and H. L. Shang (2023) "Forecasting high-dimensional functional time series: Application to sub-national age-specific mortality".

Ramsay, J. and B. Silverman (2006). Functional Data Analysis. Springer Series in Statistics. Chapter 13. New York: Springer

See Also

Two_way_median_polish

Examples

```
# The US mortality data  1959-2020 for two populations and three states
# (New York, California, Illinois)
# Compute the functional Anova decomposition fitted by means.
FANOVA_means <- FANOVA(data_pop1 = t(all_hmd_male_data),
      data_pop2 = t(all_hmd_female_data),
      year = 1959:2020, age =  0:100,
      n_prefectures = 3, n_populations = 2)

##1. The funcional grand effect
FGE = FANOVA_means$FGE_mean
##2. The funcional row effect
FRE = FANOVA_means$FRE_mean
##3. The funcional column effect
FCE = FANOVA_means$FCE_mean
```

One_way_median_polish *One-way functional median polish from Sun and Genton (2012)*

Description

Decomposition by one-way functional median polish.

Usage

```
One_way_median_polish(Y, n_prefectures=51, year=1959:2020, age=0:100)
```

Arguments

Y	The multivariate functional data, which are a matrix with dimension n by 2p, where n is the sample size and p is the dimensionality.
year	Vector with the years considered in each population.
n_prefectures	Number of prefectures.
age	Vector with the ages considered in each year.

Value

grand_effect	Grand_effect, a vector of dimension p.
row_effect	Row_effect, a matrix of dimension length(row_partition_index) by p.

Author(s)

Cristian Felipe Jimenez Varon, Ying Sun, Han Lin Shang

References

C. F. Jimenez Varon, Y. Sun and H. L. Shang (2023) "Forecasting high-dimensional functional time series: Application to sub-national age-specific mortality", arXiv. \ Sun, Ying, and Marc G. Genton (2012) "Functional Median Polish", Journal of Agricultural, Biological, and Environmental Statistics 17(3), 354-376.

See Also

One_way_Residuals, Two_way_median_polish, Two_way_Residuals

Examples

```
# The US mortality data  1959-2020, for one populations (female)
# and 3 states (New York, California, Illinois)
# first define the parameters and the row  partitions.
# Define some parameters.
year = 1959:2020
age = 0:100
n_prefectures = 3

#Load the US data. Make sure it is a matrix.
Y <-  all_hmd_female_data
# Compute the functional median polish decomposition.
FMP <- One_way_median_polish(Y,n_prefectures=3,year=1959:2020,age=0:100)
# The results
##1. The funcional grand effect
FGE <- FMP$grand_effect
##2. The funcional row effect
FRE <- FMP$row_effect
```

`One_way_Residuals` *Functional time series decomposition into deterministic (from functional median polish of Sun and Genton (2012)), and functional residual components.*

Description

Decomposition of functional time series into deterministic (from functional median polish), and functional residuals

Usage

```
One_way_Residuals(Y, n_prefectures = 51, year = 1959:2020, age = 0:100)
```

Arguments

`Y`	The multivariate functional data, which are a matrix with dimension n by 2p, where n is the sample size and p is the dimensionality.
`n_prefectures`	Number of prefectures.
`year`	Vector with the years considered in each population.
`age`	Vector with the ages considered in each year.

Value

A matrix of dimension n by p.

Author(s)

Cristian Felipe Jimenez Varon, Ying Sun, Han Lin Shang

References

C. F. Jimenez Varon, Y. Sun and H. L. Shang (2023) “Forecasting high-dimensional functional time series: Application to sub-national age-specific mortality", arXiv. \ Y. Sun and M. G. Genton (2012) “Functional median polish", Journal of Agricultural, Biological, and Environmental Statistics, 17(3), 354-376.

See Also

`One_way_median_polish`

Examples

```
# The US mortality data  1959-2020, for one populations (female)
# and 3 states (New York, California, Illinois)
# first define the parameters and the row  partitions.
# Define some parameters.
year = 1959:2020
age = 0:100
n_prefectures = 3

#Load the US data. Make sure it is a matrix.
Y <- all_hmd_female_data
# The results
# Compute the functional residuals.
FMP_residuals <- One_way_Residuals(Y, n_prefectures=3, year=1959:2020, age=0:100)
```

Two_way_median_polish *Two-way functional median polish from Sun and Genton (2012)*

Description

Decomposition by two-way functional median polish

Usage

```
Two_way_median_polish(Y, year=1959:2020, age=0:100, n_prefectures=51, n_populations=2)
```

Arguments

Y	A matrix with dimension n by 2p. The functional data.
year	Vector with the years considered in each population.
n_prefectures	Number of prefectures
age	Vector with the ages considered in each year.
n_populations	Number of populations.

Value

grand_effect	grand_effect, a vector of dimension p
row_effect	row_effect, a matrix of dimension length(row_partition_index) by p.
col_effect	col_effect, a matrix of dimension length(column_partition_index) by p

Author(s)

Cristian Felipe Jimenez Varon, Ying Sun, Han Lin Shang

References

C. F. Jimenez Varon, Y. Sun and H. L. Shang (2023) “Forecasting high-dimensional functional time series: Application to sub-national age-specific mortality".

Sun, Ying, and Marc G. Genton (2012) “Functional Median Polish", Journal of Agricultural, Biological, and Environmental Statistics, 17(3), 354-376.

See Also

FANOVA

Examples

```
# The US mortality data  1959-2020 for two populations and three states
# (New York, California, Illinois)
# Compute the functional median polish decomposition.
FMP = Two_way_median_polish(cbind(all_hmd_male_data, all_hmd_female_data),
n_prefectures = 3, year = 1959:2020, age = 0:100, n_populations = 2)

##1. The functional grand effect
FGE = FMP$grand_effect
##2. The functional row effect
FRE = FMP$row_effect
##3. The functional column effect
FCE = FMP$col_effect
```

Two_way_Residuals *Functional time series decomposition into deterministic (from functional median polish from Sun and Genton (2012)), and time-varying components (functional residuals).*

Description

Decomposition of functional time series into deterministic (from functional median polish), and time-varying components (functional residuals)

Usage

```
Two_way_Residuals(Y, n_prefectures, year, age, n_populations)
```

Arguments

Y	A matrix with dimension n by 2p. The functional data
year	Vector with the years considered in each population
n_prefectures	Number of prefectures
age	Vector with the ages considered in each year
n_populations	Number of populations

Value

residuals1	A matrix with dimension n by p
residuals2	A matrix with dimension n by p
rd	A two dimension logic vector that proves that the decomposition sum up to the data
R	A matrix with the same dimension as Y. This represent the time-varying component in the decomposition
Fixed_comp	A matrix with the same dimension as Y. This represent the deterministic component in the decomposition

Author(s)

Cristian Felipe Jimenez Varon, Ying Sun, Han Lin Shang

References

C. F. Jimenez Varon, Y. Sun and H. L. Shang (2023) "Forecasting high-dimensional functional time series: Application to sub-national age-specific mortality".

Sun, Ying, and Marc G. Genton (2012). "Functional Median Polish". Journal of Agricultural, Biological, and Environmental Statistics 17(3), 354-376.

See Also

Two_way_Residuals_means

Examples

```
# The US mortality data  1959-2020, for two populations
# and three states (New York, California, Illinois)
# Column binds the data from both populations
Y = cbind(all_hmd_male_data, all_hmd_female_data)
# Decompose FTS into deterministic (from functional median polish)
# and time-varying components (functional residuals).
FMP_residuals <- Two_way_Residuals(Y,n_prefectures=3,year=1959:2020,
                                   age=0:100,n_populations=2)
# The results
##1. The functional residuals from population 1
Residuals_pop_1=FMP_residuals$residuals1
##2. The functional residuals from population 2
Residuals_pop_2=FMP_residuals$residuals2
##3. A logic vector whose components indicate whether the sum of deterministic
##   and time-varying components recover the original FTS.
Construct_data=FMP_residuals$rd
##4. Time-varying components for all the populations. The functional residuals
All_pop_functional_residuals <- FMP_residuals$R
##5. The deterministic components from the functional median polish decomposition
deterministic_comp <- FMP_residuals$Fixed_comp
```

Two_way_Residuals_means

Functional time series decomposition into deterministic (functional analysis of variance fitted by means), and time-varying components (functional residuals).

Description

Decomposition of functional time series into deterministic (by functional analysis of variance fitted by means), and time-varying components (functional residuals)

Usage

```
Two_way_Residuals_means(data_pop1, data_pop2, year, age, n_prefectures, n_populations)
```

Arguments

data_pop1	A p by n matrix
data_pop2	A p by n matrix
year	Vector with the years considered in each population.
n_prefectures	Number of prefectures
age	Vector with the ages considered in each year.
n_populations	Number of populations.

Value

residuals1	A matrix with dimension n by p.
residuals2	A matrix with dimension n by p.
rd	A two dimension logic vector proving that the decomposition sum up the data.
R	A matrix of dimension as n by 2p. This represents the time-varying component in the decomposition.
Fixed_comp	A matrix of dimension as n by 2p. This represents the deterministic component in the decomposition.

Author(s)

Cristian Felipe Jimenez Varon, Ying Sun, Han Lin Shang

References

C. F. Jimenez Varon, Y. Sun and H. L. Shang (2023) “Forecasting high-dimensional functional time series: Application to sub-national age-specific mortality".

Ramsay, J. and B. Silverman (2006). Functional Data Analysis. Springer Series in Statistics. Chapter 13. New York: Springer.

See Also

Two_way_Residuals

Examples

```
# The US mortality data  1959-2020, for two populations
# and three states (New York, California, Illinois)
# Compute the functional Anova decomposition fitted by means.
FANOVA_means_residuals <- Two_way_Residuals_means(data_pop1=t(all_hmd_male_data),
                            data_pop2=t(all_hmd_female_data), year = 1959:2020,
                            age = 0:100, n_prefectures = 3, n_populations = 2)

# The results
##1. The functional residuals from population 1
Residuals_pop_1=FANOVA_means_residuals$residuals1
##2. The functional residuals from population 2
Residuals_pop_2=FANOVA_means_residuals$residuals2
##3. A logic vector whose components indicate whether the sum of deterministic
##  and time-varying components recover the original FTS.
Construct_data=FANOVA_means_residuals$rd
##4. Time-varying components for all the populations. The functional residuals
All_pop_functional_residuals <- FANOVA_means_residuals$R
##5. The deterministic components from the functional ANOVA decomposition
deterministic_comp <- FANOVA_means_residuals$Fixed_comp
```

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