Package 'MKendall'

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Type Package

Title Matrix Kendall's Tau and Matrix Elliptical Factor Model

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Description

Large-scale matrix-variate data have been widely observed nowadays in various research areas such as finance, signal processing and medical imaging. Modelling matrix-valued data by matrix-elliptical family not only provides a flexible way to handle heavy-tail property and tail dependencies, but also maintains the intrinsic row and column structure of random matrices. We proposed a new tool named matrix Kendall's tau which is efficient for analyzing random elliptical matrices. By applying this new type of Kendell's tau to the matrix elliptical factor model, we propose a Matrix-type Robust Two-Step (MRTS) method to estimate the loading and factor spaces. See the details in He at al. (2022) <doi:10.48550/arXiv.2207.09633>. In this package, we provide the algorithms for calculating sample matrix Kendall's tau, the MRTS method and the Matrix Kendall's tau Eigenvalue-Ratio (MKER) method which is used for determining the number of factors.

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Contents

MKER *Estimating Factor Numbers via Matrix Kendall's Tau Eigenvalue-Ratio Method*

Description

This function is to estimate row and column factor numbers via Matrix Kendall's Tau Eigenvalue-Ratio Method.

Usage

```
MKER(X, kmax)
```

Arguments

X	Input three-dimensional array, of dimension $T \times p \times q$. T is the sample size, p is the row dimension of each matrix observation and q is the column dimension of each matrix observation.
kmax	The user-supplied maximum factor numbers.

Details

See He at al. (2022) <arXiv:2207.09633> for details.

Value

khat	The estimated row factor number.
rhat	The estimated column factor number.

Author(s)

Yong He, Yalin Wang, Long Yu, Wang Zhou and Wenxin Zhou.

References

He, Y., Wang, Y., Yu, L., Zhou, W., & Zhou, W. X. (2022). A new non-parametric Kendall's tau for matrix-value elliptical observations <arXiv:2207.09633>.

Examples

```
set.seed(123456)
T=20;p=10;q=10;k=2;r=2
R=matrix(runif(p*k,min=-1,max=1),p,k)
C=matrix(runif(q*r,min=-1,max=1),q,r)
  X=Y=E=array(0,c(T,p,q))
    for(i in 1:T){
      Y[i,,]=R%*%matrix(rnorm(k*r),k,r)%*%t(C)
      E[i,,]=matrix(rnorm(p*q),p,q)
```

```
    }
    X=Y+E

fn=MKER(X,9)
fn$khat;
fn$rhat
```

MRTS *Matrix Robust Two-Step Algorithm for Large-Dimensional Matrix Elliptical Factor Model*

Description

This function is to fit the large-dimensional matrix elliptical factor model via the Matrix Robust Two-Step (RTS) algorithm.

Usage

```
MRTS(X, k, r)
```

Arguments

X	Input three-dimensional array, of dimension $T \times p \times q$. T is the sample size, p is the row dimension of each matrix observation and q is the column dimension of each matrix observation.
k	A positive integer indicating the row factor numbers.
r	A positive integer indicating the column factor numbers.

Details

See He at al. (2022) <arXiv:2207.09633> for details.

Value

The return value is a list. In this list, it contains the following:

Rloading	The estimated row loading matrix of dimension $p \times k$
Cloading	The estimated column loading matrix of dimension $q \times r$
Fhat	The estimated factor matrices, are output in the form of a three-dimensional array with dimensions of $T \times k \times r$. T is the sample size, k and r are the row and column dimensions of each factor matrix, respectively.

Author(s)

Yong He, Yalin Wang, Long Yu, Wang Zhou and Wenxin Zhou.

References

He, Y., Wang, Y., Yu, L., Zhou, W., & Zhou, W. X. (2022). A new non-parametric Kendall's tau for matrix-value elliptical observations <arXiv:2207.09633>.

Examples

```
set.seed(123456)
T=20;p=10;q=10;k=2;r=2
R=matrix(runif(p*k,min=-1,max=1),p,k)
C=matrix(runif(q*r,min=-1,max=1),q,r)
  X=Y=E=array(0,c(T,p,q))
    for(i in 1:T){
      Y[i,,]=R%*%matrix(rnorm(k*r),k,r)%*%t(C)
      E[i,,]=matrix(rnorm(p*q),p,q)
    }
    X=Y+E

fit=MRTS(X,k,r)
fit$Rloading;fit$Cloading;fit$Fhat
```

`MSK` *Estimating Row and Column Sample Matrix Kendall's Tau*

Description

This function is to estimate row and column sample matrix Kendall's tau which are defined in He et al. (2022) <arXiv:2207.09633>

Usage

```
MSK(X, type = "1")
```

Arguments

`X`	Input three-dimensional array, of dimension $T \times p \times q$. T is the sample size, p is the row dimension of each matrix observation and q is the column dimension of each matrix observation.
`type`	If type=1, calculate the row sample matrix Kendall's tau; if type=2, calculate the column sample matrix Kendall's tau. The default is the row sample matrix Kendall's tau.

Details

See He at al. (2022) <arXiv:2207.09633> for details.

Value

If type=1, the return value is a $p \times p$ matrix; if type=2, the return value is a $q \times q$ matrix.

Author(s)

Yong He, Yalin Wang, Long Yu, Wang Zhou and Wenxin Zhou.

References

He, Y., Wang, Y., Yu, L., Zhou, W., & Zhou, W. X. (2022). A new non-parametric Kendall's tau for matrix-value elliptical observations <arXiv:2207.09633>.

Examples

```
X=array(rnorm(400),c(20,5,4))
MSK(X,1)
```

Index