# Package 'sdrt'

**Type** Package

**Title** Estimating the Sufficient Dimension Reduction Subspaces in Time
Series

**Version** 1.0.0

**Maintainer** Tharindu P. De Alwis <talwis@wpi.edu>

**Depends** R(>= 3.5.0), stats

**Imports** psych, tseries, pracma

**Description** The sdrt() function is designed for estimating subspaces for Sufficient Dimension Reduction (SDR) in time series, with a specific focus on the Time Series Central Mean subspace (TS-CMS). The package employs the Fourier transformation method proposed by Samadi and De Alwis (2023) <doi:10.48550/arXiv.2312.02110> and the Nadaraya-Watson kernel smoother method proposed by Park et al. (2009) <doi:10.1198/jcgs.2009.08076> for estimating the TS-CMS. The package provides tools for estimating distances between subspaces and includes functions for selecting model parameters using the Fourier transformation method.

**License** GPL-2 | GPL-3

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 7.2.3

**Suggests** rmarkdown, knitr

**VignetteBuilder** knitr

**NeedsCompilation** yes

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**Repository** CRAN

**Date/Publication** 2024-03-28 16:30:02 UTC

## R topics documented:

**Index**                                                                                              **7**

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   dist                                    *Return the distance between two subspaces spanning by column space*
                                                  *of matrices.*

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## Description

The function calculates three metrics for measuring the distance between two subspaces spaning by
the columns of two matrices.

## Usage

```
dist(A, B)
```

## Arguments

| | |
|---|---|
| A | Matrix 1 with dimension p-by-d. |
| B | Matrix 2 with dimension p-by-d. |

## Value

The outputs include three scales and one d-dimensional vector.

| | |
|---|---|
| r | One minuse the summation of eiegenvalues of the matrix B^TAA^TB. |
| q | One minues the product of eiegenvalues of the matrix B^TAA^TB. |
| rho | rho=sqrt(A^TBB^TA) |
| m^2 | A d-variate vector giving the colum-wise distance between A and B. |

## References

Samadi S. Y. and De Alwis T. P. (2023). Fourier Method of Estimating Time Series Central Mean
Subspace. *https://arxiv.org/pdf/2312.02110*.

Ye Z. and Weiss R.E. (2003). Using the Bootstrap to Select One of a New Class of Dimension
Reduction Methods, *Journal of the American Statistical Association*, 98,968-978.

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| | |
|---|---|
| `lynx` | *Canadian Lynx Data.* |

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### Description

Annual record of the number of the Canadian Lynx 'trapped' in the Mackenzie River district of the North-West Canada for the period 1821-1934.

### Usage

```
data(lynx)
```

### Format

A data list with 114 rows containing the count of Canadian Lynx from 1821-1934.

### Source

https://www.encyclopediaofmath.org /index.php/Canadian_lynx_data

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| | |
|---|---|
| `pd.boots` | *Select the model parameters using Fourier transformation method.* |

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### Description

'pd.boots()' estimates the number of lags in the model and the dimension of the time series central mean subspace.

### Usage

```
pd.boots(y, p_list=seq(2,6,by=1), w1=0.1,  space = "mean",std = FALSE,
                                  density = "kernel", method = "FM", B=50)
```

### Arguments

| | |
|---|---|
| `y` | A univariate time series observations. |
| `p_list` | (default {2,3,4,5,6}). The candidate list of the number of lags, p. |
| `w1` | (default 0.1). The tuning parameter of the estimation. |
| `space` | (default "mean"). Specify the SDR subspace needed to be estimated. |
| `std` | (default FALSE). If TRUE, then standardizing the time series observations. |
| `density` | (default "kernel"). Density function for the estimation ("kernel" or "normal"). |
| `method` | (default "FM"). Estimation method ("FM" or "NW"). |
| `B` | (default 50). Number of block bootstrap sample. |

## Value

The output is a p-by-p matrix, estimated p and d.

| | |
|---|---|
| dis_dp | The average block bootsrap distances. |
| p_hat | The estimator for p. |
| d_hat | The estimator for d. |

## References

Samadi S. Y. and De Alwis T. P. (2023). Fourier Method of Estimating Time Series Central Mean Subspace. *https://arxiv.org/pdf/2312.02110*.

## Examples

```
data("lynx")
y <- log10(lynx)
p_list=seq(2,5,by=1)
fit.model=pd.boots(y,p_list,w1=0.1,B=10)
fit.model$dis_pd
fit.model$p_hat
fit.model$d_hat
```

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|  sdrt  | *Estimate the SDR subspaces for univariate time series data.* |
|---|---|

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## Description

'sdrt()' is the main function to estimate the SDR subspaces in time series.

## Usage

```
sdrt(y, p, d, w1 = 0.1, space = "mean", std = FALSE,
                                 density = "normal", method = "FM",n.grid=10)
```

## Arguments

| | |
|---|---|
| y | A univariate time series observations. |
| p | Integer value. The lag of the time series. |
| d | Integer value (<p). The dimension of the time series central mean subspace. |
| w1 | (default 0.1). The tuning parameter of the "FM" estimation method. |
| space | (default "mean"). Specify the SDR subspace needed to be estimated. |
| std | (default FALSE). If TRUE, then standardize the data. |
| density | (default "kernel"). Specify the density function for the estimation ("kernel" or "normal"). |
| method | (default "FM"). Specify the estimation method ("FM" or "NW"). |
| n.grid | (default 10). Number of searches for the initial value in "NW" method |

## Value

The output is a p-by-d basis matrix for the TS-CMS.

## References

Park J. H., Sriram T. N. and Yin X. (2010). Dimension Reduction in Time Series. *Statistica Sinica*. 20, 747-770.

Samadi S. Y. and De Alwis T. P. (2023). Fourier Method of Estimating Time Series Central Mean Subspace. *https://arxiv.org/pdf/2312.02110*.

## See Also

[pd.boots](), [sigma_u]()

## Examples

```
data("lynx")
y <- log10(lynx)
p <- 3
d <- 1
fit.model <- sdrt(y, p, d=1,method="FM",density = "kernel")
fit.model$eta_hat
```

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| sigma_u | *The tuning parameter for the estimation of the time series central mean subspace* |
|---|---|

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## Description

'sigma_u()' estimates the turning parameter needed to estimate time series central mean subspace in Fourier Method.

## Usage

```
sigma_u(y, p, d, w1_list=seq(0.1,0.5,by=0.1),space="mean",
                         std=FALSE,density="kernel",method="FM",B=20)
```

## Arguments

| | |
|---|---|
| y | A univariate time series observations. |
| p | Integer value. The lag of the time series. |
| d | Integer value. The dimension of the time series central mean subspace. |
| w1_list | (default {0.1, 0.2,0.3,0.4,0.5}). The sequence of candidate list for the tuning parameter. |
| space | (default "mean"). Specify the SDR subspace needed to be estimated. |

| std | (default FALSE). If TRUE, then standardizing the time series observations. |
| --- | --- |
| density | (default "kernel"). Specify the density function for the estimation ("kernel" or "normal"). |
| method | (default "FM"). Specify the estimation method. ("FM" or "NW"). |
| B | (default 20). Number of block bootstrap samples. |

## Value

The output is a length(sw2_seq) dimensional vector.

| dis_sw2 | The average block boostrap distances for each candidate list of values. |
| --- | --- |

## References

Samadi S. Y. and De Alwis T. P. (2023). Fourier Method of Estimating Time Series Central Mean Subspace. *https://arxiv.org/pdf/2312.02110*.

## Examples

```
data("lynx")
y <- log10(lynx)
p <- 3
d <- 1
w1_list=seq(0.1,0.5,by=0.1)
Tuning.model=sigma_u(y, p, d, w1_list=w1_list, std=FALSE, B=10)
Tuning.model$sigma_u_hat
```

# Index